

This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

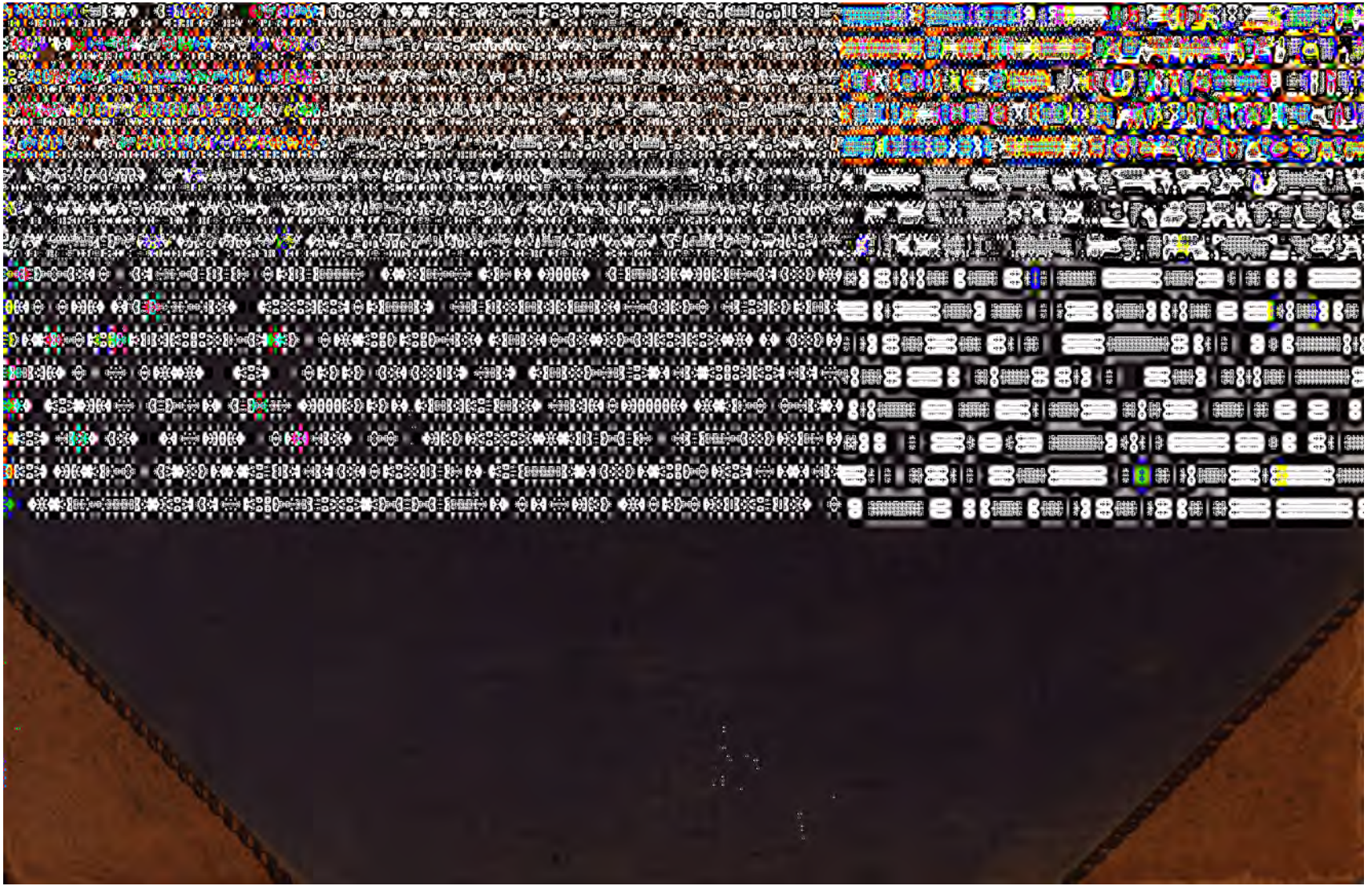
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

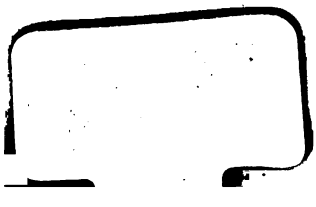
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

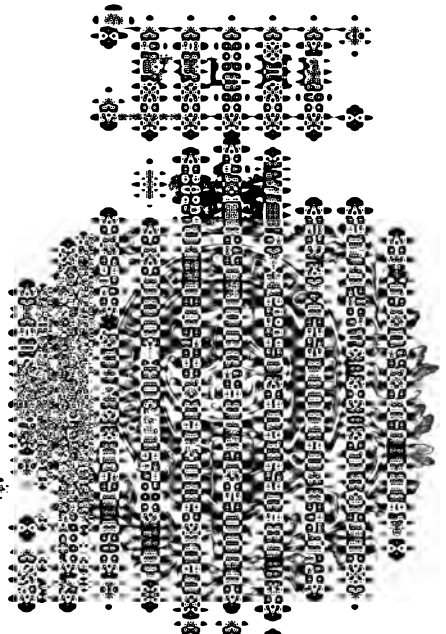


Sec. 23181 e. $\frac{260}{3}$



[illegible] Constitution,

[illegible] THE COUNCIL.



LONDON:
[illegible] AND SON,
[illegible]
[illegible]
1850.

PARLIAMENT ST., WESTMINSTER.

ROYAL UNITED SERVICE INSTITUTION.

PATRONS.

HER MAJESTY THE QUEEN.

FIELD MARSHAL HIS ROYAL HIGHNESS THE PRINCE CONSORT.

VICE-PATRONS.

COLONEL H.R.H. THE PRINCE OF WALES, K.G.

GENERAL H.R.H. THE DUKE OF CAMBRIDGE, K.G. &c. &c.

FIELD MARSHAL HIS MAJESTY THE KING OF THE BELGIANS, K.G. &c. &c.

Wood, Rt. Hon. Sir Charles, Bart. M.P. Secretary of State for India.
Panmure, Rt. Hon. Lord.
Northumberland, Rear-Admiral His Grace the Duke of, K.G. F.R.S. &c.
Strafford, Field-Marshal Right Hon. the Earl of, G.C.B. G.C.H.
Douglas, General Sir Howard, Bt. G.C.B. G.G.C.M.
Richmond, Colonel His Grace the Duke of.
Hardwicke, Vice-Adm. the Right. Hon. the Earl of.
Holdsworth, Col. A. H. Yeom. Cav.
Graham, Rt. Hon. Sir James, Bart. M.P.
Broughton, the Right Hon. Lord, G.C.B.
Baring, Rt. Hon. Sir Francis T. Bart. M.P.
Beresford, Rt. Hon. W. M.P.
Murchison, Sir Roderic I. G.C.St.S. F.R.S. &c.
Norfolk, His Grace the Duke of, late of the Royal Horse Guards.
Herbert, Rt. Hon. Sidney, M.P. Secretary of State for War.
Peel, Major-General Rt. Hon. J. M.P.
Pakington, Rt. Hon. Sir John, Bart. M.P.
Somerset, His Grace the Duke of, First Lord of the Admiralty.

TRUSTEES.

Rear-Admiral His Grace the Duke of Northumberland, K.G. F.R.S. &c.
His Grace the Duke of Norfolk, &c. &c.
Colonel A. H. Holdsworth, Yeom. Cavalry, Governor of Dartmouth.

PRESIDENT.

THE DUKE OF NORTHUMBERLAND, K.G. &c. &c.

VICE-PRESIDENTS.

Smyth, W. H. Vice-Admiral, K.F.M. D.C.L. F.R.S. F.S.A. F.R.G.S. &c.
Fox, C.R, Lieut.-General.
Stanhope, P. Spencer, Major-General.
Back, Sir George, Rear-Admiral, D.C.L. F.R.S. &c.
Yorke, P. J. Col. late Scots Fusilier Guards, F.R.S.
Lindsay, Hon. James, Colonel Gren. Guards, M.P.
Pollock, Sir G. General, Bengal Army, G.C.B.
Hamilton, F. W. Colonel, Grenadier Guards, C.B.
Herbert, Sir Thomas, Vice-Adm. K.C.B.
Alcock, T. St. Leger, Lieut.-Col.-Commandant Royal E. Middlesex Militia.
Ford, John, Capt. Royal Hosp. Chelsea.
White, Loraine, Major.

COUNCIL.

1860.

CHAIRMAN—Captain E. G. Fishbourne, R.N. C.B.
VICE-CHAIRMAN—Colonel the Hon. James Lindsay, M.P.

Ryder, A. P. Captain R.N.
Cooke, A. C. Major R.E.
Stuart, J. F. D. C. Lt.-Col. Gren. Guards, M.P.
Collinson, R. Capt. R.N. C.B.
Packe, E. Captain, late Royal Horse Guards.
Fishbourne, E. G. Captain R.N. C.B.
Jefferson, R. Capt. h.p. Ceylon Rifles.
Scott, Sir S. Bart. late Capt. Roy. Suss. Mil. Art.
Read, Constantine, Lt.-Col. h.p. Roy. Staff Corps.
Sykes, W. H. Colonel, Ret. Bom. Army, F.R.S. M.P.
Keppel, F. C. Lieut.-Col. Gren. Guards.
Wiseman, Sir William, Bart. Capt. R.N.
Barrow, John, Esq. F.R.S. late Admiralty.
Watkins, W. Maj.-Gen. Col. 48th Madras N.I.
Tyler, H. W. Captain R.E.
Jervoise, W. F. D. Major R.E.
Lacon, W. Stirling, Esq. late H.E.I.C.S.S.
Tupper, A. C. Capt. late Edmonton Royal Rifles.
Nolloth, M. S. Capt. R.N.
Nicolson, Sir Frederic, Bart. Captain R.N.
Fox, A. Lane, Lieut.-Colonel Gren. Guards.
MacQueen, James, Capt. h.p. 3rd Light Dragoons.
Le Couteur, J. H. Lieut.-Colonel Coldm. Guards.
Key, Astley Cooper, Captain R.N.

SECRETARY AND CURATOR—Captain Boughey Burgess.

BIBLIOTHECA BODLEIANA

CONTENTS OF VOLUME THE THIRD.

Page

An Account of some Experiments elucidating the Theory on which the Author founds his Patented Method of Manufacturing Cannon; also of the endurance of some Guns and other Cylinders made to test the practical value of this Method. By Capt. BLAKELY, R.A., M.R.I.A., F.R.G.S., &c. 1

The Organisation of the Army of India, with especial Reference to the Hill Regions. By HYDE CLARKE, D.C.L., Vice-Pres. of Geolts. Assoc., &c. . . 18

The Ordnance Survey. By Col. JAMES, R.E., F.R.S., &c. 28

The Importance of a Knowledge of the Elements of Surgery to Naval and Military Officers. By W. H. FLOWER, Esq., F.R.C.S. 39

The Financial and Executive Administration of the British Indian Empire. By Lieut.-Col. J. P. KENNEDY 50

Chairman's Address, first Evening Meeting. Col. the Hon. JAMES LINDSAY . 87

Notes on the Magnetism of Ships. By F. J. EVANS, Esq., R.N., F.R.A.S. . 91

The Effect of the Introduction of Rifled Cannon on Naval Architecture. By Capt. FISHBOURNE, R.N., C.B. 112

National Defence, or New Strategies in Warfare. By J. MACKINTOSH, Esq. . 132

Meteorology. By Rear-Admiral ROBERT FITZROY, F.R.S. . . . 135

The Valley of the Yang-tse-Keang before and since the Inroads of the Rebels, as far as the Commercial Port of Hankow. By Sir JOHN F. DAVIS, Bart., K.C.B. . 162

The Rifle and the Spade, or the Future of Field Operations. By Capt. TYLER, R.E. 170

Napoleon's Campaign in Italy in 1796. By Col. MACDOUGAL, Commandant Royal Staff College, Sandhurst 195

The Application of Statistics to Naval and Military Matters. By W. FARR, Esq., M.D., F.R.S., &c. 209

His Diagonal Principle of Iron Ship Building. By R. TAYLERSON, Esq. . . 227

Tents, from their earliest Period to the present Time; showing the necessity for providing Waterproof and Well-ventilated Tents for the Covering of Troops in the Field, and the evil Results when inefficient Shelter is provided: considered in a Sanitary and Pecuniary Point of View. By Major RHODES . . . 237

The Military Character of the Great Duke of Marlborough. By Col. MACDOUGALL, Commandant Staff. Coll., Sandhurst 257

New Zealand considered as a Field for the Emigration of Military Men. By Capt. C. CHESNEY, R.E., Prof. of Hist. Staff Coll., Sandhurst 271

On the Advantage of cultivating the Natural and Experimental Sciences, as promoting the Social Comfort and Practical Utility of Military Men. By Major-Gen. PORTLOCK, Member of Council of Military Education, F.R.S., &c. . . 290

Gun-locks and their History. By Mr. R. T. PRITCHETT 307

On Rotatory Motion applied to obtain Stability for Astronomical Observations at Sea. By Prof. BADEN POWELL, M.A., F.R.S., &c. 314

Page

The Acclimation of European Troops for Service in India, and the Organization there most suited to secure Efficiency in the Field. By JAMES BIRD, Esq., M.D., F.R.C.P., &c. 324

The Screw Fleets of England and France in 1859-60. By C. L. PICKERING, Esq. . 338

Flexible Propellers. By JAMES REDDIE, Esq. 361

Proceedings of the Twenty-ninth Anniversary Meeting, and Annual Report for 1859 i

Address of the Right Hon. EARL DE GREY AND RIPON xiv

Proceedings at a Special General Meeting for consideration of the Bye-laws . . xvi

Proceedings at a Special General Meeting, on the subject of applying for a Royal Charter of Incorporation and for Revision of the Bye-laws of the Institution . xxii

Statement of Changes among the Members during 1859 xxvi

Tabular Analysis of the State of the Institution to 31 Dec. 1859 . . . ib.

Members paying Increased Subscriptions during 1859 87, 111, 225, 237, 337, 359

Donations . . . . . 87, 225, 237, 337, 359, xxvii

New Members during 1859 . . . . 87, 111, 225, 237, 337, 359, xxviii

Presents received for the Library and Museum . 87, 111, 225, 237, 337, 360, xxx

CHARTER OF INCORPORATION.

BYE-LAWS.

THE

Journal

OF THE

United Service Institution.

VOL. III. 1859. No. IX.

LECTURES.

Friday, January 21st, 1859.

Colonel the Hon. JAMES LINDSAY in the Chair.

AN ACCOUNT of some EXPERIMENTS elucidating the THEORY on which the AUTHOR founds his PATENTED METHOD of MANUFACTURING CANNON; also of the ENDURANCE of some GUNS and other CYLINDERS made to TEST the PRACTICAL VALUE of this METHOD.

By Captain BLAKELY, R.A., M.R.I.A., F.R.G.S., &c.

WHEN, last year, I had the honour of advocating before this Institution a new method of constructing cannon, I made use of arguments based on the rudimental principles of geometry to prove the great waste of materials by the present system of manufacture. I argued—

1st. That any tube pressed on from within must stretch.

2ndly. That in stretching it must become thinner.

3rdly. That, the sides of the tube becoming thinner, the outer parts, particularly of a thick tube like a gun, must be less stretched, therefore less strained, than the inner; because, to permit of their being as much stretched, the sides would have to become absolutely thicker and the mass of material greater than at first.

4thly. That a tube in which the outer parts are less strained than the inner must be weaker than if all could be equally strained.

As this line of argument proved ineffectual in convincing any of the persons charged by Government to provide this country with cannon, thousands of the largest calibre of which have been cast within the last year, I felt great satisfaction in finding, a few weeks ago, an account of a series of experiments which completely corroborate the view I attempted, with so little success, to inculcate.

These experiments were made by Major Wade, of the U.S. Ordnance, for his government, which has been so liberal as to publish them, together with many other most interesting and valuable researches, in a book entitled "Reports of Experiments on Metals for Cannon." I will mention such of them as throw light upon the four proportions which form the heads of my argument.

Proposition 1.

A tube pressed on from within stretches.

In 1846 Major Wade, when testing some muskets by hydrostatic pressure, found the elasticity of sound barrels such, that a column of water in them, 21 inches high, could be diminished half an inch by a pressure of 2,000 lbs. A column of water 39 or 40 inches high he shortened $\frac{1}{8}$ of an inch with a pressure of 2,400 lbs. When the pressure was removed the water recovered its original height nearly.

This result cannot have been owing to the compression of the water, which would have been imperceptible with such a slight pressure; the musket barrels, therefore, must have increased in diameter during the strain: *q. e. d.*

In 1851 Major Wade measured the change in size of some hollow cast-iron cylinders, when strained from within by hydrostatic pressure. Not only were they all enlarged during the continuance of the pressure, but *in every case an addition of pressure produced an increase of diameter.* The second column of the accompanying table gives the actual measurements by Major Wade of the diameters of these cylinders when strained by the force mentioned in the first column. The uniformity of the result in such a number of cases is nearly conclusive.

Proposition 2.

A tube when stretched must become thinner.

The column in this table headed "thickness of metal" was calculated by me from Major Wade's data, the size of the inner and outer diameter. We here find that each increase of strain diminished the thickness of the tube: *q. e. d.*

Proposition 3.

The outer portions of a tube are less stretched by pressure from within than the inner portions, and the greater the thickness of the tube the greater is the difference.

The table of Major Wade's experiments proves that in No. 1 cylinder, where the sides were less than one-third of a calibre in thickness, the

EXTENSION OF HOLLOW CYLINDERS.

CYLINDER No. 1.

Force applied.	Diameters in Inches.		Ratio of Increment to the original Diameters.		Outside less stretched than Inside.	Thickness of Metal.	Area of Cross Section.
	Interior.	Exterior.	Interior.	Exterior.			
lbs.							Sq. Inches.
0,000	·8050	1·3090	One in	One in	As one to	·2520	·83681
1,000	·8061	1·3093	732	4,367	$5\frac{4}{10}$	·2516	·83603
2,000	·8083	1·3100	277	1,309	$4\frac{3}{4}$	·25085	·83468
3,000	·8102	1·3110	155	655	$4\frac{1}{2}$	·25040	·83432
4,000	·8114	1·3120	126	437	$3\frac{1}{2}$	·25080	·83486
5,000	·8126	1·3130	107	327	$3\frac{1}{3}$	·25020	·83439
6,000	·8141	1·3140	88	262	3	·24995	·83554
7,000	·8153	1·3150	78	218	$2\frac{8}{10}$	·24985	·83607
					Average $3\frac{1}{2}$		

CYLINDER No. 2.

0,000	·8030	1·812	. .	. .	. .	·5045	2·0723
5,000	·8030	1·812	. .	. .	. .	·5045	2·0723
8,000	·8053	1·813	349	1,812	$5\frac{1}{2}$	·50385	2·0722
10,000	·8067	1·814	217	906	$4\frac{1}{2}$	·50365	2·0733
12,000	·8085	1·815	146	604	$4\frac{1}{4}$	·50325	2·0739
14,000	·8110	1·816	100	453	$4\frac{1}{3}$	·50250	2·0736
					Average $4\frac{1}{2}$		

CYLINDER No. 3.

0,000	·8100	1·8120	. .	. .	. .	·50100	2·0635
5,000	·8100	1·8120	. .	. .	. .	·50100	2·0635
8,000	·8124	1·8127	337	2,588	$7\frac{3}{4}$	·50015	2·0624
10,000	·8137	1·8130	219	1,812	$8\frac{1}{4}$	·49965	2·0616
12,000	·8151	1·8134	159	1,294	$8\frac{1}{7}$	·49915	2·0609
14,000	·8171	1·8140	114	906	8	·49845	2·0600
					Average 8		

CYLINDER No. 4.

0,000	·8070	1·811	. .	. .	. .	·50200	2·0644
5,000	·8124	1·812	149	1,811	$12\frac{1}{7}$	·49980	2·0604
8,000	·8166	1·814	84	604	$7\frac{1}{2}$	·49870	2·0606
10,000	·8177	1·814	75	604	8	·49815	2·0593
12,000	·8205	1·815	59	453	$7\frac{3}{4}$	·49725	2·0585
14,000	·8211	1·815	57	443	$7\frac{3}{4}$	·49695	2·0578
					Average $8\frac{1}{2}$		

outer diameter was increased on an average $3\frac{1}{2}$ times less than the inner; and that in cylinders 2, 3, and 4, where the metal was $\frac{5}{8}$ of a calibre thick, the outside was stretched on an average seven times less than the inside: *q. e. d.*

Proposition 4.

A tube in which the inner parts are more strained by pressure from within than the outer must be weaker than if all could be equally strained.

In October, 1844, Major Wade burst two 18-pounder cast-iron guns by hydrostatic pressure to find their strength. He afterwards carefully tested the strength of the metal to resist a direct tensile strain. One of these guns burst with a pressure of 9,000 lbs. per inch of resisting metal, yet a sample bar of the gun showed a strength of 27,350 lbs. per inch. The other burst with a strain of 6,082 lbs. per inch, whereas the sample showed a tensile force of 22,204 lbs. Here we have proof that some part of the metal did not exert its strength, and that in each of these guns at least the useless part amounted to the great proportion of more than two-thirds of the whole.

In his report to the Colonel of Ordnance at Washington Major Wade wrote on the subject as follows:—

"The relation between the force applied in producing a fracture in cast iron by a tensile strain in the axis of the specimen, and by that of hydrostatic pressure within the bore, appears to be somewhat greater than as three to one."

Another experiment made by Major Wade a few weeks later showed that it is the outside parts of cylinders which do not exert their strength.

He turned down the outside of a 6-pounder cast-iron gun in a lathe to such an extent as to form, from the breech near to the trunnions, a cylinder of the uniform thickness of one calibre, that is to say, with a thickness of metal on every side equal to the diameter of the bore. He cut off the trunnions, and turned a second cylindrical portion in the middle of the gun with a thickness of half a calibre. In front he formed a third cylinder with metal only one quarter of a calibre thick.

With a hydrostatic pressure of 12,400 lbs. per square inch, the thin part burst in four fissures. The piston was then inserted in the middle part where the metal was half a calibre thick, and a pressure of 20,000 lbs. burst it in three fissures, one of which extended 16 inches into the thick cylinder. In his report Major Wade wrote as follows :—

"It appears from these results, that the power of resisting in cylinders of the same quality of iron, and of the same diameters of bore, but of different thickness, varies as the thickness, but in a less ratio. Hence the increase or the diminution of the thickness of iron in a gun does not increase or diminish the strength in like proportion. The results obtained in former trials by water-pressure with those now obtained from the 6-pounder gun are all given in the following table :—

Kind of Iron.	By testing Instrument.	By water pressure per square Inch.		Thickness of Iron in parts of radius of bore.	Ratio of resistance by water pressure, the tensile strength being the unit = 1·000.
	Tensile strength per square Inch.	Within the bore.	On the area of fracture.		
18-pounder No. 1	27,350	9,000	9,000	1·000	0·329
18-pounder No. 2	22,204	9,860	6,082	1·621	0·273
6-pounder . .	33,226	12,400	24,800	0·500	0·742
		20,000	20,000	1·000	0·602

Here we see that the 6-pounder, where only one-fourth of a calibre thick, required a pressure of 12,400 lbs. per inch of bore to burst it; but that with double the thickness of metal, an addition of only 7,600 lbs. pressure, or about five-eighths of the former, sufficed to destroy it. The second equal thickness of metal, then, only exerted five-eighths as much power as the inner, the total strength being less than if they had been equally strained.

But the strength of the thinnest part was only in this experiment three-quarters (0·742) so much as if the whole of it even had been equally strained; the strength of the medium thickness therefore was only six-tenths, little more than half so much as if it had all been strained as much as the inside of all: *q. e. d.*

Although these experiments would by themselves be insufficient to establish a theory, and although I was unable by reasoning, founded on pure science, to convince many persons of the soundness of my views, still I trust that the mutual corroboration of argument and experiment will have greater effect. Here, in England, an opinion is expressed, that for certain reasons, cylinders if strained would stretch, and stretch more inside than outside; in America a number cylinders are measured during strain, and without exception all do stretch with every increase of strain, and all do stretch more inside than outside. This certainly makes it appear probable that the reasoning on which the opinion is founded is correct, and that all cylinders would follow this law.

In the case of iron tubes, an experiment which any one can make is decisive as to the stretching. A leaden ring fitted on such a tube will stretch with it when strained, but will remain enlarged when the iron is permitted to regain its original size. Mr. Greener of Birmingham made a series of experiments with the barrel of a fowling-piece, having leaden rings at intervals on it, for the purpose of showing how much each part was enlarged during the discharge of the piece. Where he found this enlargement less than at other parts he concluded that the barrel was stronger than necessary, and modelled the next he made accordingly.

The enlargement of tubes when pressed on from within, being thus proved beyond the possibility of doubt, the simultaneous diminution in the thickness of their sides will be readily admitted. No person could

expect a ring which fitted a little finger to be enlarged to fit a first finger without becoming thinner. Now any thick cylinder or tube may be considered as composed of several concentric smaller ones ; and it is evident that each of these, by becoming thinner when stretched, loses some of its power of pressing the one above it. As an example, let us imagine a thick cylinder (see fig. 1.) as composed of two concentric cylinders, accurately fitting, of which the inner one is exactly like No. 3 in Major Wade's experiment (see p. 3) ·8100 inch bore, and 1·8120 inch in outer diameter, the latter being also the measure of the inner diameter of the outer tube. Now, referring to the table of the experiments (see p. 3), we find that on applying pressure from within, until the inner diameter, A B, stretches from ·8100 to ·8124 inches, 1 in 337, the outer diameter of the inner cylinder, C D, would, if quite unopposed, only stretch from 1·8120 to 1·8127 inches, or 1 in 2588. But we now imagine over this tube another, which must resist its expansion; C D would therefore stretch less. To avoid theory, let us adhere, however, to Major Wade's figures, and say that C D would not stretch more than 1 in 2588, nearly eight times less than the inside. Evidently the inside of the outer cylinder would continue to touch the other, and must therefore stretch exactly as much ; that is, 1 in 2588, A B, the inside, stretching 1 in 337. If the outer cylinder be of the same proportions as the inner, and of the same metal, we may fairly conclude that E F, its outer diameter, would stretch as much less than C D as C D stretched less than A B. This would only be 1 in 19,973, or sixty times less than A B.

The whole of our outer cylinder, therefore, could be very little strained when the inside was stretched 1 in 337. To stretch the inside more would endanger its soundness, and, however much we strain it, the outer cylinder will remain about eight times less strained, that is to say, will exert eight times less power than it. Major Wade found the result the same, whether he applied a small or a great pressure. When he stretched the inner diameter 1 in 114, which must have approached the point of rupture, the outside still only yielded 1 in 906.

The outer parts of a thick cylinder are almost precisely in the same condition of uselessness as if they formed a separate tube, fitted with perfect accuracy over an inner one; and the stretching of C D, the diameter of the middle part, will be as little in proportion to that of the inside, if the division of which it is the diameter is imaginary, as if it were real.

It is evident that if we could make the outer cylinder stretch as much with any given pressure as the inner, instead of eight times less, we should get eight times as much effective strength from it. This is easily done: *we have but to form the thick cylinder of two or more concentric ones; but, instead of making them so as to fit accurately, each must be slightly too small to go over the one underneath it without force.*

If, for example, over the inner cylinder we have been considering, whose outer diameter is 1·8120, we place another whose inner diameter is only 1·8074, or about $\frac{1}{100}$ of an inch less (see fig. 2), then, when pressure from within enlarges the whole to such an extent that A B, the inner diameter of the inner tube, is stretched 1 in 337, and C D, its outer diameter, 1 in 2,588, or from 1·8120 to 1·8127 (see table, page 3), the inner diameter of the outer cylinder will not, of course, be stretched

Fig. 3



Section through the Trunnions

J.R.Jobbins

beyond 1·8127; but, having been originally only 1·8074, this will suffice to strain it as much as the inside—53 in 18,074, or 1 in 337.

By this simple contrivance the outside could be made to perform in this case eight times as much work as if it were cast in one piece with the rest, or merely accurately fitted on.

When the outer diameter of the inner tube is stretched to 1·8127 inches the inner diameter of the outer tube must also become 1·8127 inches. If it is originally 1·8120 inches, it is then extended 1 in 2,588; but, if only the $\frac{1}{100}$ of an inch less, or 1·8074 inches originally, then it is stretched 1 in 337.

We could, of course, regulate the extension of the two cylinders so as to be equal with any other amount of pressure; or we could make a greater number of cylinders, thin or thick, all expand equally with a certain amount of strain, by making the inside of each less than the outside of the one under it by a certain very small quantity.

Nothing is easier than to put one tube over another, though the outside of the lesser one be slightly larger than the inside of the other. The application of heat will expand the latter; and, when in position, the withdrawal of the heat will permit it to shrink and grasp the inner tube so tightly as to compress it. This operation is, however, uncertain in its effect; in practice, therefore, I would make the outer surface of one tube, and the inner surface of the other, slightly conical or tapering, and force one over the other with a hydrostatic press. The amount of strain and stretching can thus be accurately adjusted.

The method of constructing cannon which I to-day submit to your judgment is, then, simply to form such parts of them as require great strength of concentric tubes, each slightly too small to go over the one below it without force; *the amount of this difference in size being so regulated that with a certain amount of pressure each tube shall be equally strained,* or that the outside (which can be replaced if broken) shall be most strained. One of these tubes should extend the entire length of the gun, the others may be formed of more convenient sizes. I will presently show various ways in which I arranged them for experiment.

I am told that the introduction of steel for the manufacture of cannon renders my invention unnecessary. I am, however, inclined to believe that, the more valuable is the metal employed, the less John Bull will like to pay for its being so used that it cannot do an eighth of its work; particularly as it requires more skill and more expensive machinery to make guns in one huge mass, of which much is useless, than it does to make them in several pieces so constructed that each shall perform nearly all the work of which it is capable.

I must here state that since I last had the honour of addressing this Institution, I have discovered from the book I have already referred to, "Reports of Experiments on Metals for Canon," published in America in 1857, that I am not the first person who proposed a remedy for the unequal straining of the parts of a gun. In 1851 Lieutenant Rodman of the United States Ordnance proposed, *for that purpose,* to cast guns hollow and cool them from within. On the 30th July of that year, at his suggestion, an eight-inch gun was cast hollow by means of a core formed on a tube of cast iron. Through this a stream of water was kept circulating

until the gun was cool. By this means Mr. Rodman made the inside solidify first. The next layer solidified, of course, at a greater temperature than that of the extreme inside at that moment, as this had already had a short time to cool and contract.

Had the outside of the gun been kept liquid until all the rest had gradually become solid, giving out all heat through the core only, doubtless the gun would have been in a condition very nearly approaching that required by theory, so far as the initial tension on the external portions is concerned. As it was, the gun was much stronger than another cast solid at the same time, of the same size, and of the same metal. The latter burst after 73 rounds with 10 pounds of powder and one 64-pound shot; that cast hollow was fired 1,500 times with the same charge, and is, I believe, still sound.

Not only then did Mr. Rodman forestall me in the idea of remedying the evil of unequal strain in cannon, but he proposed a really efficient remedy. I believe that my remedy is better, cheaper, and adapted to guns very much larger than the other; but I must still be content to occupy the second place in the discovery and application of this principle of construction. It is lucky for my *amour propre* that Mr. Rodman's scientific attainments are of that order that to follow him at any distance is an honour.

On the 21st August, 1851, two ten-inch guns were cast at New York from the same metal, one solid and one hollow. The latter was cooled from within like the eight-inch gun, but the outside was also allowed to cool, though more slowly. These guns were proved by repeated firing with 18lbs. of gunpowder and one 124lb. shot.

The gun cast solid burst at the twentieth round, the other stood 249 rounds. When examined afterwards, the gun cast hollow was found to be, in one part, fissured, as shown in section in fig. 3, the outside and inside having solidified before the middle. It is probable that even where no absolute fissure was found, the portion of metal intermediate between the two cooling surfaces was less dense than it should have been.

One advantage my plan certainly has: I can use, to obtain the greater part of the resistance required, a metal much stronger than cast iron, while retaining that metal for the interior of the tube, for which part it is so suited; thus securing the hardness and inflexibility of cast iron, and the tensile force of the toughest steel. Wire even, the strongest form of iron or steel, can be used with great advantage in some cases.

The saving in size of guns, therefore, in expense of transport would be enormous. This is, however, a very small matter, in my opinion, compared to the advantage of, by this means, being enabled to make cannon of a size and strength hitherto impossible, and still impossible by any means which do not ensure that each part shall do its work.

Nothing would be so conducive to peace as arming the vulnerable parts of every coast with guns so powerful that one or two shells from them could destroy a ship. Few have any idea how inadequate to the end desired are the means often employed.

The conflict which took place between the "Guillaume Tell" (afterwards the "Malta") and the "Foudroyant" 74, the "Lion" 64, and the "Penelope" frigate, during the last war with France, supplies an example:

The "Foudroyant" ranged up alongside about 6 A.M., approaching the French ship so closely that her spare anchor just escaped catching in the mizen rigging of the "Guillaume Tell."

The action was continued closely till 8·20 A.M., when the "Guillaume Tell" struck. On this occasion the "Foudroyant" expended—

1,200 32-pound shot
1,240 24-pound do.
118 18-pound do.
200 12-pound do.

Being a total of 2,758 shot, weighing 72,584 lbs., fired at short distances, besides those fired from the batteries of the "Lion" and the "Penelope;" yet the "Guillaume Tell" was not sunk, nor so much injured as to be incapable of service soon afterwards in the British navy.*

Wishing to-day to abstain entirely from theory, I will not speculate on what would have been the fate of any ten ships if fired into for two hours and twenty minutes from a few 24-inch shell-guns, but will, as concisely as I can, give an account of some experiments made to prove the practicability of making such.

My first experiment was to shrink a heated wrought-iron ring over one of cast iron. The result was the compression of the latter to an extent I by no means expected, the wrought iron being only slightly expanded. When separated, both tubes regained their original size.

I next made an 18-pounder gun, of which fig. 4 shows the longitudinal section. It was formed of a tube of cast iron, $5\frac{1}{4}$ inches inner diameter, and $1\frac{3}{4}$ inch thick, over which were shrunk, side by side, short cylinders of wrought iron, the thickest of which was 2 inches.

To resist the force of the gunpowder, therefore, this gun had a total thickness, where strongest, of only $3\frac{3}{4}$ inches; that of a service cast-iron 18-pounder being upwards of $5\frac{1}{2}$ inches. Yet the lesser thickness was quite sufficient, even though the initial strain, calculated as necessary on the outer tubes, had been but very roughly approximated.

As a cast-iron tube, $1\frac{3}{4}$ inches thick, was insufficient to resist the longitudinal strain, and as the wrought-iron cylinders were not joined, but merely placed side by side, four rods were used to give additional strength lengthways. These were fastened at one end to a ring carrying the trunnions, and at the other to an iron plate, which they pressed against the breech end of the gun. Two of these rods and the trunnions are not shown in the longitudinal sections, but are seen in the cross-sections. This gun was much stronger than necessary at the front part; indeed everywhere, except just round the seat of the charge. I regret, now, that I only fired it enough to prove that it was an efficient 18-pounder gun; had I continued till it burst, its strength relatively to service-guns would have been more definitely known. Being desirous, however, before injuring it to find out if a still thinner cast-iron core would suffice, I had this 18-pounder bored out to the size of a 24-pounder. Unluckily, in so doing the bore was not made in the centre, only half-an-inch of cast iron being left at one side of it (see fig. 7). Even in this state, however, it bore, without injury, several hours firing with charges varying from one shot and four pounds of powder, to one shot, two wads, and eight pounds of powder. It burst at the third round with the latter charge. This

* Charnock's Life of Nelson.

great strength was unexpected, the thickness of metal round the charge being only 2½ inches; whereas, in a service 24-pounder it is upwards of 6 inches. My gun, too, had much less windage. It weighed 15 cwt., less by 5 cwt. than the reamed-out 24-pounders which are used with a service-charge of 2 lbs. 8 ozs. of powder. The iron service 24-pounder for an eight-pound charge weighs 48 cwt.

The next experiment I made was to get a 9-pounder service-gun turned down cylindrical from the trunnions to the breech, and on this part to place wrought-iron tubes nearly the exact size and weight of the portion of metal removed, but just the necessary fraction of an inch smaller. Fig. 8 shows this gun in section. The wrought-iron tubes had dove-tailed flanges, so that the one clasping the other gave some longitudinal strength; not that I think this was necessary. Indeed, if outer tubes had been placed merely half-way to the trunnions, strength enough would have been attained. This gun was fired as follows:—

2	rounds	with	8	lbs of	powder and	2 shot
86	,,		3	,,	,,	1 ,,
26	,,		4	,,	,,	1 ,,
5	,,		5	,,	,,	1 ,,
5	,,		5	,,	,,	2 ,,
318	,,		6	,,	,,	2 ,,
1	,,		6	,,	,,	3 ,,
1	,,		6	,,	,,	4 ,,
1	,,		6	,,	,,	5 ,,
1	,,		6	,,	,,	6 ,,
1	,,		6	,,	,,	7 ,,
1	,,		6	,,	,,	8 ,,
1	,,		6	,,	,,	9 ,,
158	,,		6	,,	,,	10 ,,

A cast-iron service-gun, of about the same size and weight, was fired, round for round with this gun until the 110th round, with six pounds of powder and two shot, when the cast-iron gun burst. The superiority of mine was so evident, that Her Majesty's Government had a 68-pounder and a 10-inch gun made almost on the model of it. The 68-pounder made in 1857 will, I hope, be tested this year or next.

A comparison of figs. 7 and 8 will justify my own astonishment at the strength of the 15 cwt. 24-pounder.

My fourth gun was an 18-pounder, of which fig. 9 shows a section of the breech end. The inner cast-iron tube was only 1 inch thick, and open at both ends, the breech being closed by a plug. This was decidedly a mistake, throwing too great a strain on the four longitudinal bolts with which this gun, like my first, was provided, though these are not shown in the figure. Over the cast-iron tube I put two layers of wrought-iron tubes; the first, broad, thin tubes (five-eighths of an inch thick), the outer ones, thicker and shorter. By making the two layers break joint, additional stiffness was obtained. This gun was fired—

1	round	with	6 lbs. of	powder 1 wad and	1 shot
1	,,		9	,, ,,	,,
1	,,		10½	,, ,,	,,
1	,,		12	,, ,,	,,

At this round the four bolts gave way, although each was 2¼ inches thick—the four united being equal to a solid bar the size of the bore of the gun. The rest of the gun was uninjured, so that this trial was a great success so far as the method of obtaining lateral strength was concerned, the sides being at the thickest part only 3⅛ inches thick. The charge which broke this gun was twelve pounds of powder—double the service-charge for guns more than double the weight, and four times the service-charge of the 21-cwt. service-gun. I had this gun remade with four bolts of the best charcoal iron; but they, too, broke without injury to the tubular part. Though so far most satisfactory, this result made me decide not again to leave the entire longitudinal strain to be borne by outer bars.

My fifth gun, which I made in 1856—those I have mentioned having been made in 1855—was a 12-pounder. The longitudinal strain I divided between four bars, attached as in former guns, and the cast-iron central tube which took half this strain, its breech-end, to insure this, having an aperture only half the size of the bore (see fig. 10). This gun had two layers of wrought-iron cylinders.

The manufacture of this gun showed me the great uncertainty of the result of shrinking heated iron tubes. Those for this gun had been made of the same iron, carefully bored to the same diameter, and heated equally; yet about two feet in front of the breech they had compressed the cast-iron core so much more than in other parts, that the bore was there $\frac{1}{10}$ of an inch less. This determined me in future always to force the outer tubes on cold, making the outside of the inner tube a little conical, tapering towards the breech-end. Great accuracy can thus be obtained. Indeed, the method of heating and shrinking on the tubes I had only adopted as a cheaper makeshift for the first few experimental guns. Knowing from former experiments that it would be useless to attempt to burst this gun with ordinary charges, it being much stronger than any former ones, I had long iron cylinders cast and turned accurately to fit the bore. Unfortunately, I had too great confidence in it; and, instead of waiting a day or two and having the compressed part again bored out cylindrical, I fired these closely-fitting cylinders from it. Having put in the powder for the fourth or fifth round, the cylinder was introduced, but stuck in the narrow part, and we could not get it out again. Thinking that the gun was too strong to be burst by gunpowder in any way, I fired it. It burst.

Nothing could have been more injudicious than firing the gun so loaded. Not having any means of calculating the strain on it, nothing would have been proved had it remained sound. I should have been particularly careful, too, of this fifth gun, because I could not afford to make a sixth. This fifth gun proved nothing; but in all the others the increase of lateral, or rather circumferencial, strength by my method of manufacture was great—indeed greater than I had expected.

These guns had been made to test a principle, not as models. They would all have been too light for service, except the 9-pounder. In No. VII. (Vol. II.) of the Journal of the Proceedings of this Institution, page 323, I have given drawings representing the proportions and the method of manufacture I would recommend for large guns—to throw a ton of iron, for instance.

I will here (see fig. 11), therefore, give a drawing of an 18-pounder field and siege gun I should like to see supersede the 38-cwt. gun now used. This gun would have double the strength, would cost less originally, and, weighing only 22 cwt., the transport would require fewer horses. Only the breach-end would require the strength of the double tube; but for some purposes it would be well to have a few guns made as light as possible. In these the principle should be applied the whole length of the gun. By using wire the weight of an 18-pounder gun could with safety be reduced from 38 cwt. to 8 cwt.

Shortly after I had taken my patent for cannon (February 1855), Mr. James Longridge took one for making hydraulic presses on the same principle. To test it he had some small brass cylinders cast (some are on this table), one inch in diameter and one-tenth of an inch thick. Round these he coiled steel wire with a tension calculated to make each coil share in the work. When filled, the cylinders could each contain 300 grains of the strongest sporting gunpowder. He put a certain portion of gunpowder into these, then at each end placed a copper globe, ground to fill up the aperture accurately, with the exception of a small touch-hole. The whole was then bound together by a strong wrought-iron strap, the section of which was about $2\frac{1}{2} \times 1\frac{1}{2}$ inches, and the balls keyed tight up to their seats by a jib and cottar. The powder was then exploded with the following results:—

EXPERIMENTS WITH BRASS CYLINDERS AND STEEL WIRE.

No. of Experiments.	No. of Cylinders.	No. of Coils of Wire, &c.	Charge of Powder.	Results.
			Grains.	
1	1	Without wire . . .	50	Slightly bulged.
2	„	ditto . . .	60	ditto
3	„	ditto . . .	70	Ditto to $1\frac{5}{16}$ outer diameter.
4	„	ditto . . .	80	Ditto to $1\frac{7}{16}$ ditto
5	„	ditto . . .	90	Burst.
6	2	2 coils $\frac{1}{24}$in. wire . .	90	No effect.
7	„	Ditto, one end of wire loose	100	Bulged at loose end and wire uncoiled.
8	3	Without wire . . .	70	Bulged to $\frac{11}{12}$.
9	4	6 coils of $\frac{1}{24}$in. wire .	100	No effect.
10	„	ditto . . .	110	ditto
11	„	ditto . . .	120	Ditto, end of wire came loose.
12	5	Same cylinder as No. 4 but only 1 coil of wire.	100	Burst, end of wire was badly fastened and wire uncoiled.
13	6	2 coils of $\frac{1}{12}$in. wire .	100	No effect.
14	„	ditto . . .	120	ditto
15	„	ditto . . .	130	ditto
16	7	4 coils of $\frac{1}{12}$in. wire .	120	ditto
17	„	ditto . . .	130	ditto
18	„	ditto . . .	140	ditto
19	„	ditto . . .	150	ditto
20	„	ditto . . .	160	ditto
21	„	ditto . . .	180	ditto
22	„	ditto . . .	200	ditto

From this we see that the same cylinder which, unsupported, was

bulged by 50 grains of powder, and burst by 90 grains, could bear the explosion of 200 grains when reinforced by four coils of wire, each only one thirty-third of an inch thick. The initial strain on each coil being so adjusted that each was equally strained with the greater charge. For this purpose the first coil was put on with a slight strain, the next with a greater, the third with a greater still, and so on.

Mr. Longridge next experimented with cast-iron cylinders, one inch in diameter and one-tenth inch thick, but close at one end. The other he secured much in the same way as in the brass cylinders. When filled these cylinders could hold 305 grains of powder. They were strengthened with iron wire coiled on with the requisite increasing tension. The following were the results of the experiments.

EXPERIMENTS WITH CAST IRON CYLINDERS AND IRON WIRE.

No. of Coils of Wire.	Charge of Powder.	Results.
	Grains.	
8 Coils, No. 21 wire gauge . .	200	No effect.
ditto	220	ditto
ditto	240	ditto
ditto	250	ditto
ditto	260	ditto
ditto	270	ditto
ditto	280	ditto
ditto	290	ditto, hoop on flange shifted.
4 Coils, No. 21 wire gauge . .	200	No effect.
ditto	210	ditto, cracked in flange.
Without wire	40	No effect.
ditto	50	ditto
ditto	60	ditto
ditto	70	ditto
ditto	80	Burst.

With eight coils of No. 21 iron wire, then, it appears that these cylinders could bear the explosion of 95 per cent. of as much gunpowder as could be put into them.

To find if it was the material which gave this strength, and not the method of making each part do its work, Mr. Longridge obtained a piece of the best wrought-iron, and made a cylinder similar to the others in size of bore, but with sides *twenty times as thick*. This burst with a charge of 100 grains of powder.

Mr. Longridge next made a three-pounder gun of a copper tube, with iron wire coiled on it. It was meant to be fired with its breech abutting against some resisting substance; but at Woolwich they fixed it with the front flange resting against a piece of timber, and, of course, blew the breech off. To test the strength of this cylinder Mr. Longridge afterwards loaded it, buried it in the earth between two strong pickets firmly driven in, and fired the charge. It showed enormous strength.

Mr. Longridge next made a gun of a thin cast-iron tube, with wire coiled round it. It weighed only 3 cwt., yet threw a 9-pound shot 1,500 yards.

Last year, with his permission, I exhibited here a 6-inch hydraulic press, which he had made of cast-iron three-quarters of an inch thick, with wire coiled round it with a carefully-calculated increasing strain to a thickness of half an inch. This press was sent to a gentleman at Glasgow to be tested; he reports that it has borne a pressure of upwards of seventeen tons per inch! One-fourth of this would have destroyed most cast-iron cylinders of treble the thickness.

Time, I regret, will not permit me to describe any other of Mr. Longridge's valuable experiments. I will only mention one more experiment to-day, but that a most important one, because made by Colonel Treuille de Beaulieu, a distinguished French artillery officer, and one of the *Comité d'Artillerie* of France. He had a 32-pounder (French 30-pounder) turned down cylindrical from the breech to near the trunnions. Over this he shrunk steel tubes, accurately bored.

At first sight this looks very like my plan (see fig. 9); but I regret to say that I cannot quite agree with Colonel Treuille in his method of construction.

The steel he uses is very tough, and similar to that wonderful metal now made so inexpensively by the Mersey Steel Company. Like it, it can be stretched one-fifteenth of its length without breaking, and one one-hundred-and-fiftieth without losing its elasticity. Colonel Treuille made his outer tubes only one three-hundredth of their diameter less than the outside of the cast-iron cylinder. This was about 16½ English inches in diameter; the bore of the gun being about 6½ inches. Now, this cast-iron cylinder is thicker in proportion to its bore than any of those Major Wade tried. The outsides of his were stretched but one-eighth as much as the inside, *when free to expand.* I do not think that in Colonel Treuille's 32-pounder, therefore, the outside of the cast-iron cylinder, encompassed by a strong steel envelope, can expand more than one-tenth as much as the inside of the gun. Granting, even, that his cast iron can be stretched 1 in 300 without danger (which I doubt), still the outside would only be increased, even then, 1 in 3,000. One three-hundredth added to one three-thousandth would then be the greatest elongation of the steel possible, without fracturing the inside of the cast iron. Nearly one-half of the strength of the steel is thus made no use of.

As it is, the gun is strong enough to resist any strain by gunpowder in a lateral direction. When Colonel Treuille first showed and explained it to me, I ventured to express an opinion that the breech would eventually be blown back, owing to the great squareness of the end of the bore in French guns. I had the honour of seeing that gentleman, however, a fortnight ago, and was rejoiced to find, as I am sure you will all be glad to hear, that hitherto neither this nor any other catastrophe has occurred. On the contrary, the gun has borne 1,000 proof-charges without the slightest injury except to the vent, which, of course, has been more than once renewed.

Although I think that Colonel Treuille could have obtained equal strength by the use of one-half the quantity of steel, had he made the steel cylinders one four-hundredth part less in diameter, still, as he actually does make them do ten times as much work as if they were not in a constant state of tension, I hope I may fairly consider him as an authority,

and a most weighty one, in favour of the principle of construction I am advocating.

His method of manufacture must not be confounded with that proposed, years ago, by General Thierry, who thought to obtain the rigidity of cast iron and the strength of wrought iron by simply placing tubes of the latter metal over one of the former metal. Guns were so made, which looked exactly like Colonel Treuille's, or mine; yet they were perfect failures. The reason is obvious: the strain was not communicated to the wrought iron, as it had no initial tension, or, at most, only enough to give it a firm hold on the interior.

The difference of opinion between Colonel Treuille and myself is only as to the degree of disproportion between the useful effect of the inside and the outside of cylinders. He thinks that, in the 32-pounder he made, the outside of the cast iron part, which was about 50 inches in circumference, could exert two-fifths as much strength as the inside, which was about 20 inches in circumference; the diminution being in the direct proportion of the diameter. Now, I believe that the diminution is in a greater ratio than even the squares of the diameters; in the above case more than 25 to 4, instead of 5 to 2.

This question is of such importance in deciding the *necessity* of abandoning the present method of making guns by casting, that I trust you will permit me to discuss it a little fully.

Those who, like Colonel Treuille, argue that the strain is in the inverse ratio of the diameter, must believe that the thickness of metal remains constant whatever the pressure; for under no other conditions would one part be exactly as much elongated as another. Even on this view of the case, the outside of a service-gun, which is fully three times greater in circumference than the inside, could only do one-third as much work, because an elongation which would strain a fibre of one length to a certain amount, could only strain a fibre three times as long, one-third as much.

I have already given reasons why the metal must decrease in thickness when strained; I will now, therefore, only refer to Major Wade's experiments (see page 3), which show that in every instance he tried such was the case.

Those who argue that the strain is in the inverse ratio of the squares of the diameters, believe that the thickness of the metal diminishes as the circumference is increased by pressure from within, but that the total bulk of the metal remains constant; and that, therefore, the area of the surface of metal, which would be exposed by making a cross-section through the cylinder, perpendicular to its axis, must be also constant whatever the pressure. Now, on this hypothesis even, the outside of a cast gun could not do more than one-ninth of its work, *yet in all Major Wade's experiments the cross-section was decreased by strain* up to a certain point, which proves that the *useful effect of the metal must have decreased in a greater proportion than even the squares of the distance from the centre.*

Had I not found an account of these experiments, I should have despaired of ever convincing any but persons possessing a knowledge of science that guns are at the present time being cast by thousands in such a manner that fully two-thirds of the metal in them is not only utterly

useless but most mischievous, because rendering their transport more difficult and expensive; *and that the extreme outsides of the present guns cannot exert one-twelfth of the power they could be made to exert.*

These experiments are valuable to me also as establishing the truth of another argument I used here on a former occasion. It is constantly asserted that the pressure of the gas of gunpowder amounts to ten or twelve tons per square inch of surface, and that its action being sudden is more mischievous than an equal pressure applied more slowly. As guns do bear the repeated application of this pressure, I was told that I must exaggerate their weakness. My reply was, that the shot, by moving directly the first particles of powder burn, leaves room for the rest to expand gradually, and that the pressure can never be so great as is said, because such pressure acting through a certain space must necessarily produce a greater velocity than we know is produced. The belief in the great pressure of the products of powder, which has been handed down to us from former generations, must now at last yield to demonstration. Major Wade burst a serviceable 18-pounder gun behind the trunnions with a pressure of 4½ tons per inch. The pressure of the gunpowder must therefore have been less than 4½ tons per inch, or at all events less destructive than that pressure longer applied. This is very important, upsetting all preconceived ideas of the violence of the explosion of gunpowder in the cannon now used. In larger guns the pressure of course would be greater, because the shot would acquire motion more slowly, therefore would leave less room for the igniting powder. Hence the larger the gun the greater the difficulty of getting it to resist the explosion; hence the utter impossibility of making guns beyond a certain size to fire full charges of powder without making more than one layer of metal take its fair share of work.

In rifled cannon this limit is reached in a smaller calibre than in smooth bores, because the resistance of the twist and of the friction prevents the shot moving from its place rapidly enough to leave room for the gas of the powder, which being thus confined exerts more power. This additional power has been turned to advantage by Mr. Armstrong, but has hitherto baffled Mr. Whitworth, in his endeavours to obtain good results from rifled cannon. The 32-pounder and the 68-pounder made by the latter were burst by the pressure in the gun, though the shot was of iron only and not tightly fitting. Mr. Armstrong's guns, on the other hand, bear without injury the much greater pressure resulting from the use of a bullet covered with lead and fitting extremely tight. His bullets, indeed, are made larger than the general bore of the gun, are inserted at the breech end, where the barrel is slightly wider, and are forced by the gas of the powder through the narrower part. The pressure of this gas must be enormous, because the powder must have time to be entirely burnt before the shot moves many inches, resisted as it is.

How then does Mr. Armstrong obtain power, accuracy, great velocity, and extreme range from a pressure much greater than that which destroys Mr. Whitworth's guns? How can he use a pressure capable of giving such velocity to his bullets, that a twist not half so rapid as Mr. Whitworth uses is yet sufficient to ensure accuracy which must be seen to be credited?

I will answer these questions by quoting the words in which Captain

Younghusband, R.A., described the manufacture of Mr. Armstrong's guns to the Royal Artillery Institution in April, 1856:—

"A core, or internal lining for the gun, was formed of cast steel, to which the requisite strength was given by encircling it with twisted cylinders of wrought iron, made in a similar manner to gun barrels, and tightly contracted upon the steel core by the usual process of cooling after previous expansion by heat; *the parts are then in that state of initial tension which is necessary to bring their entire strength into operation.*"

This "initial tension" of the outside of the guns is then the difference between Mr. Whitworth's and Mr. Armstrong's, between failure and unexampled success; and it is this "initial tension" of the outer parts which I have been advocating for upwards of four years, which I have endeavoured to advocate to-day, as not only beneficial but absolutely necessary when great strength is required.

It is but fair to Mr. Armstrong to state, that, judging from dates, his first gun must have been commenced long before I published my views, although after I had taken a patent and made one or two guns. We, therefore, arrived independently at the same conclusion.

Though I claim to share with him the honour of the invention of the means of obtaining *strength* in cannon, yet the marvellous accuracy he attains, the ingenuity and simplicity of his plan for loading by the breech, the perfection of his fuze, the skilful shaping of his shell and of the inside of his barrel, the scientific way in which he secures the great pressure, guarding against any waste of it; these and many other advantages are due to him and to him only (so far as I know), and I am confident you will all join me in hoping he may receive the hearty gratitude of his country for his patient, laborious, most scientific, and most successful researches.

I will conclude by taking the liberty of intreating any of you whom I have been able to convince of the truth of my views to promulgate them. I venture to make this request now, because every cannon foundry in the kingdom is busy making guns which in a year or two must be obsolete; and because, what is far more dangerous, we are planning expensive means of defending our seaports against guns now in use, against guns which we will heed no more than bows and arrows by the time our defences against them are completed. Those defences I need hardly say will be useless against cannon which can be made and which in a year or two will be made.

Friday, January 28th, 1859.

LT.-COL. T. ST. LEGER ALCOCK, Vice-President, in the Chair.

ON THE ORGANISATION OF THE ARMY OF INDIA, WITH ESPECIAL REFERENCE TO THE HILL REGIONS.

BY HYDE CLARKE, D.C.L.,

Vice-Pres. of the Geologists' Association, Fellow of the Statistical Society, Cor. Mem. of the Institute of Engineers of Vienna, &c., Agent for the English Settlers in the Darjeeling Country.

INDIA for military and topographical purposes must be considered with reference to maritime communication, internal domination, and external aggression.

As the basis of our military power in India is the supply of soldiers of our own race, a free communication with the sea must be kept up, and the command of the seaports be held by us. The command of the seaports and of the broad river channels and deltas, is not however mainly dependent on a military force, as it can be kept up by the naval department.

Except in the Dekkan, the main military stations are far remote from the seaports, and in the north, the rivers Burhampooter, Ganges, and Indus form at present the channels of communication.

Within the territory of India, military stations and arsenals must be formed for holding the population in check.

On the sea-frontier, there is at the present moment little danger from external aggression, even in case of a war with France; but on the circle of the northern frontier, are the hostile or threatening populations of the wild tribes and of the Chinese; but, what is of far greater importance, we have to provide against the advances of the Russians, as ambitious as ourselves, and whose ambition is not sated with the acquisition of the intervening countries, but has for its special object the domination of India, by the introduction of an invading military force and by raising the local populations.

Thus any plan for the military organization of India must provide for all the objects here defined; but there is no such organization for India, as its military administration has grown up piecemeal, as our empire has extended, accommodating itself to circumstances, and mainly dependent on the incorporation of a large body of native soldiery. So long as this state of affairs remained, the organization of the administration was impeded by many obstacles, and, it is almost needless to say, was attended with imminent danger, as great under any change as under the existence of the then system.

We may be disposed to think, that, as a revolt of the native army was inevitable, it was fortunate it happened when it did. It settled conclusively the policy of dependence on a native force, and it happened just at

the period when our acquisitions of territory placed us in a situation to form our establishments in positions suited to our own wants, instead of being obliged, as before, to conform to the requirements of a native army. Thus heretofore the stations were selected to suit the tropical constitutions of the native army, and not the constitutions of our own men. The arsenals were consequently placed, as at Delhi for example, within the command of an unreliable force.

If the governors of India choose, the re-organization of the Indian armies can proceed unshackled by the former system, and on such bases as, in a political and military point of view, are most consistent for our own objects.

Considered politically, our purpose must evidently be, so far as practicable, to dispense with the native element; and to rely upon the European element, as the constituent of the military force. To effect this we must place the Europeans where they can be healthy and efficient; and in doing so we have this advantage, that such stations are unfavourable generally to the native troops. So far as the main purposes of the army of India are concerned, this can be done, with the additional advantage, of securing the country from external aggression and internal insurrection.*

India as a military province consists of the two divisions of the lowlands or tropics, and uplands or temperate regions. Hitherto the tropical regions have been occupied by our garrisons, and the graves of our men; the uplands, recently acquired, and little occupied by the people of the plains, have received small attention, and have not, therefore, been fully considered in reference to their military relations. They have been in some places selected for invalid depots, but, strangely enough, the very experience which proves their fitness for garrisons has been little regarded, except by the medical authorities; and to men eminent for their scientific endowments and their zealous and disinterested exertions for the benefit of their fellow-countrymen—to such distinguished men as Julius Jeffreys and Ronald Martin, we owe the formation of establishments, and the progress of public opinion, which now enables us seriously to contemplate the introduction of a European force into India, as a necessary and practicable measure.

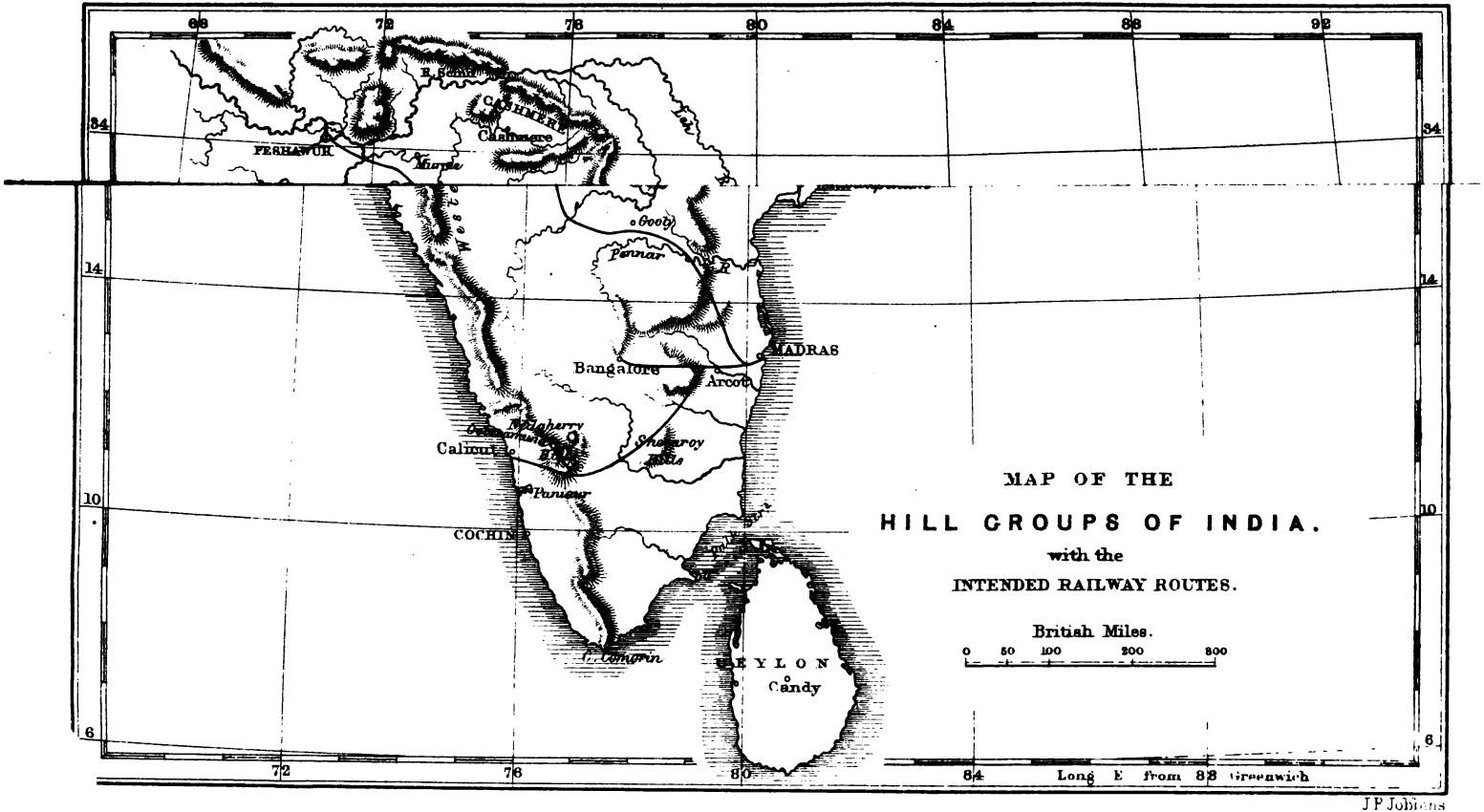
Again, the individual researches of the officers of our army, and even their sports and love of adventure, have contributed to make known to us these hill countries, and to prove their adaptation for English occupation. There are, however, few of us who have contemplated the extent of the hill regions as a whole, their resources, and their importance for military purposes. We rather regard the difficulties, the temporary obstacles, want of communication, the barrenness of some districts, the scanty population of others, the remoteness which seems to shut them off from English settlement. We have so long looked at India through false media, that we cannot contemplate the government of India in its right aspect. We are willing enough to accept the occupation of Fraser River, to believe in the advancement of Australia, to speculate on the spread of the English race through the south of Africa; but India has been too long believed to be the tomb of the Englishman, for us to be ready to regard any portion of it as his home.

* Indian Railways, Colonization, and Defence. By Hyde Clarke, 1856.

Let us take Bengal,—our military view of it is as a chain of garrisons and arsenals on the Ganges, supplied from Calcutta and communicating by the river, and this we take as an accepted fact; yet, it is not one which we should be readily disposed to allow, if we took a broader view of the resources of the country. Let us next pass from the north to the Dekkan. There we have the long line of the Western Ghauts close to the coast, accessible from numerous ports, and having a naval station at Bombay. On these Ghauts, and on the table-land attached, are places of moderate temperature, suitable for English occupation, and there is no military reason why the stations should not be there placed, instead of in the low-lands of Madras. Stations on these Ghauts, as those in the neighbourhood of Poonah for example, are accessible from the sea, and command the Malabar coast, and are convenient depots for commanding the country to the east, the rivers of which, rising in the Western Ghauts, flow from west to east, and are therefore more easily to be penetrated from the upper ranges than by moving upwards from the Coromandel coast. The stations on the Coromandel coast, first occupied by Europeans, as Madras and Pondicherry, command, it is true, the commercial outlets for produce, but as garrisons they lie at the foot of the hill country, which embarrasses the movements upwards, and any lateral movement along the coast must be made across river deltas, or across successive river channels. Thus for all districts south of the Kistnah, the military force should be stationed in the western high districts, where the troops can be kept healthy and efficient. Already troops landed at Bombay can be at once carried up to Poonah by railway, and down for embarkation for Kurrachee, for stations on the coast, and for return to England.

What has been provided for Bombay can be provided for other parts of the Malabar coast; and railways running up from the shore, would at once place the Europeans in a European climate, ready to descend on the districts of the interior. This plan is already laid down for the southern part of the peninsula, where a branch of the Madras Railway will connect the Neilgherries and Shevaroys with the ports on the Malabar shore, which are now accessible to coasting steamers. Thus it will be seen, that a base of operations has been already constituted, which will change the whole military administration of the south of India. If indeed commanders-in-chief are appointed for the two southern presidences, the one will be stationed with his staff, not at Bombay, but at Poonah, and the other, not at Madras, but on the Neilgherries or the Shevaroys.

By placing other stations on the Ghauts, and having communications with them, the whole of southern India will be held by an English force co-operating with the Indian navy, in ordinary times, traversing the presidencies by railway, in times of difficulty, holding the natural strong places of the country, and sweeping the river valleys. In the hills will be the invalid establishments, the military schools, and the residences of the officials, and the expenditure on this account will afford resources for maintaining a large civil population. The hill tribes are few and weak, and the country is left open for English occupation. Attached to these hill fastnesses are the table-lands of Mysore and other districts, in which coffee and tea cultivation is extending, and in which English capital and enter-


68
72
76
80
84
88
92
34
14
10
6
PESHAWUR
Cashmere
Ootacamund
Bangalore
Arcot
MADRAS
Calicut
COCHIN
Candy
CEYLON
C. Comorin
MAP OF THE
HILL GROUPS OF INDIA.
with the
INTENDED RAILWAY ROUTES.
British Miles.
0 50 100 200 300
Long E from 88 Greenwich

J P Jobbins

prize can find scope for exertion. Thus the military force will be backed by a powerful civil reserve, always able to hold the hill stations by militia and volunteers, and to have every man, horse, and gun of the garrisons available for operation in the field as the telegraph summons.* As the English force would be always healthy, its effective strength would be greater, and, as it would require no guards, depots, and detachments for arsenals and reserves, it would be a real field force.

It is very desirable to consider the condition of the southern Presidencies; because, that which elsewhere may be considered novel and experimental, is precisely that which is here being gradually carried out.

In the space here afforded, it is impossible to consider full details; we can only give attention to some of the larger groups; this however is preferable, as it enables us to lay down general principles instead of suggesting details on immature information.

Central India, or the valleys of the Nerbuddah and the Nuddy, has, according to the principles on which we are now arguing, its military stations in the ranges and table-lands on each side of those valleys. At present these ranges are little known and explored, but the progress of the railways uniting Bengal and Madras, will give us better means for becoming acquainted with them. Enough is however known in the certainty, that there are peaks and table-lands of European climate.

One of the first duties of the Government should be the exploration of these ranges, and their occupation by English military establishments and settlements. Recent events will show us the importance of this. We at once interpose a barrier between the native states of the centre and the north-west, commanding the Rajpoots and the Mahrattas, by a double line of posts and settlements strengthened by the Nerbuddah, through which a trunk line of railway would be safely maintained.

From this centre, Nagpore and the northern dominions of the Nizam would be controlled, the Rajpoot states, and the upper country of the Jumna and the Ganges.

In Rajpootana, we have a strong detached position already marked out for occupation, by the station of Mount Aboo. This military region must be extended.

Let us now direct our attention to the groups of hill states and sanataria to the north of Delhi, in which are included Simla, Landour, Mussoorie and Almorah.

By the help of strong garrisons in this district, with the force in the Rajpootana range and the Nerbuddah force, the whole of the upper valleys of the Ganges are effectually commanded. Delhi, Agra, Cawnpore, Allahabad, and the military stations and arsenals attached to them, in this aspect become of minor importance. They command the passes of the rivers, but the hill states command the doabs of the rivers, and the whole of the valleys can be swept. Arsenals in the Vindyha range can be supplied by railway when Delhi is inaccessible, and the communications with Calcutta become less important, when there is the choice of communi-

* Report on Telegraphic Communications in India made to the H. E. I. Co., by Francis Whishew and Hyde Clarke, 1849.

cations from Kurrachee and from Bombay, and even from Surat and minor ports.

In a like way, the hill state nucleus and the Aboo district would co-operate in restraining the valley of the Indus, forming too the second and minor line, on which the outer garrisons in the ranges around the Punjab would repose.

We have now inspected most of India, except the districts of the Lower Ganges and the Burhampooter. There, we have likewise hill stations, already partially occupied, and admitting of extension. Due north of Calcutta, is Darjeeling or English Sikkim, with a healthy climate and productive lands around. This was only a small invalid depot, but is now being converted into an English cantonment. The late Government of India began this policy, but since the accession of Lord Stanley, as Secretary of State for India, the hill cantonments have been considerably extended.

In the middle of the bend of the Burhampooter valley, we have the hill group of Sylhet, which, although of wet climate, admits of being garrisoned and has the advantage of coal mines. In Upper Assam healthy stations are to be found, and there is considerable scope for the formation of English establishments. At the present moment these stations are remote; but all the main military stations of the North-west, of the Punjab, and of Central India, are remote from the coast, and the communication is tedious. The railway line from Calcutta to Darjeeling, called the Northern Bengal, only requires the construction of two hundred miles of railway, and then it gives access, not only to Darjeeling, but to Assam, and the upper valley of the Burhampooter.

Thus the whole of India can be formed into military districts, having strong centres with English troops, and civilians constituting reserves, and affording, for internal or external movements, several armies kept ready for the field, instead of being employed as now in moving idly about India and garrisoning unhealthy fortresses.

The rapid communication and transit of these armies and of their material, must be provided by railways, in substitution for the existing method of long land-marches with countless followers, or of steamboat conveyance on the great rivers. Some have a preference for river steamers, and an objection to railways, because railways can easily be obstructed. It is however forgotten, that in time of war, as has been lately exemplified, the traffic of a river may be stopped, by a local fortress or a battery of field guns. At all periods, however, river transit is inferior for troops, because it wastes time, and is unfavourable to discipline. One day on a railway will do what fourteen days and nights will do on a river, and there is, after all, a better chance of keeping a railway open than a river. Troops can march past the obstructed portion of a railway, and make use of a further portion; but the steamer that is stopped by a fort, though its passengers may make their way round by the rear of the fort, cannot readily find conveyance again. Railways as military instruments are not inferior to rivers, although we are little accustomed to consider their employment.

For the establishment of a permanent force in India, the measures required are, the formation of more hill cantonments, the further encouragement of hill settlers, and the provision of railways and tramways, which,

first begun for military purposes, will speedily bring a revenue from their civil employment.

The Government now has small stations or cantonments at or in Sylhet, Darjeeling, Almorah, Nynee Tal, Mussorie, Simla, Murree, Mount Aboo, Poonah, and the Neilgherries. In the last years these establishments have been increased, and new cantonments formed at Darjeeling and Nynee Tal.

The main trunk railways, fortunately enough, form a base for the required extensions, and in some places they afford the necessary communication. Thus the Poonah command is connected with Bombay—the north-east and the south-east. A provision is made for the Neilgherries and the Shevaroys, by the lines in southern Madras. The main line of the East Indian Railway not only provides half of the route to Darjeeling, but runs near the upper hill stations, admitting of branches being readily formed. Through the Dehrah Dhoon, or the district under Simla, should be carried the proposed Simla Railway, so as to keep under command the connection between the East Indian and the Punjab Railways.

The achievement of what is needful, does not require a large expenditure by Government, but it does require liberal encouragement from Government, and a wise administration. Much has been begun, and we have only to persevere in that course of policy to realise the desired results. The hills and table-lands of India afford resources equal to those of any of our colonies, and the public have but to be made acquainted with the facts, to direct thither a portion of that emigration which has created new states in Australia, South Africa, and Canada. Such an emigration of English, Irish, Welsh, and Highlanders, would be, as elsewhere, recruited by Germans, Jews, and the adventurous spirits, who seek protection and prosperity under the flag of England. In many parts of the hill regions the aborigines are few and weak; but in other places, there are numerous hill tribes like the clans of Scotland, having no sympathy with the population of the plains, and who can be made ready allies.

This is one special advantage of the hill system, that, whereas elsewhere in India we must be isolated, in the hills we can easily in a few years, from our own people and the hill tribes, draw together a warlike population of a million, and from which we can safely draw recruits, because the women and children will be left within our own quarters. Such a population would of itself be a great resource, beyond any we now possess, far better than a Sepoy population, far better than the present precarious assistance of Ghoorkas and other hillmen.

It may now be useful to regard the hill positions in reference to their external relations. Thus, in Upper Assam, and on the Burmese frontier, by the proper constitution of our garrisons, we acquire the means of commanding the upper valleys of the rivers of Burmah and Siam—countries with which our intercourse is yearly becoming closer and of more importance to us. In Assam we are not only at the head of the great rivers falling into the Malay seas, and at the head of the Burhampooter, but we are within a very little distance of south-west China, and the valley of the Yang-tse-Kiang. At present a few wild tribes and the difficulties of the mountain passes impede intercourse; but with the removal of these, India will be opened to the teeming populations of China, and the social,

industrial, and political, results of the immigration will be great. We have been accustomed to regard the Hindoo population of Bengal as presenting a mass of millions of men, to whom the institutions of India must be subservient; but a Chinese immigration will produce far different results. Attracted into the Assam valley, by the demand for labour in the tea and other plantations, the Chinese will spread into the valley of the Ganges; and thus we shall, perhaps in a very few years, find the population of India intermixed, and therefore, more plastic to our institutions, than the unmixed indigenous population.

Darjeeling is another most interesting point placed between Bhotan and Nepaul. It secures the former hill country from the ambition of the latter, we may say, for the exercise of our own ambition; for Bhotan, in its distracted state, requires the exercise of English intervention. To eastern Thibet, and Central Asia, Darjeeling commands one of the routes for trade and communication, and it is our barrier against Nepaul.

Nepaul is politically, and practically, one of our great dangers in India. Constantly excited to ambitious designs on India, Nepaul is for the time restrained by the caution of the despot of the moment, but, by its turbulent tribes, Oude, and all our rich provinces on the northern bank of the Ganges are always threatened. So long as this state of affairs exists, Darjeeling must be strengthened, fortresses must be maintained on the Ganges, and the hill sanataria of the Simla ranges must be strongly held. In the end, Nepaul will be pacified by the influence of English settlement.

The Simla group of hill states is the district which presents the least promise of resources. Much of it consists of barren mountains and precipitous valleys, and, Simla being better known than the other Indian hill districts, an unfavourable opinion is formed by those acquainted with it, of the resources of the hills. The group is not however so unfavourable as is supposed.

In the Dhoon, as Sir Proby Cautley and Sir John Login have stated, there are lands capable of reclamation, and there are many places where the tea cultivation can be carried on, while the mineral productions are considerable. When the iron and other deposits of Kumaon are properly worked, the Simla group may not prove the least important of our hill territories. We have there clustered together a variety of countries of various geological constitution, and of various mineral productions, reaching from Gurhwal on the east, to Simla on the west.

It has been lately computed by an Indian authority, that, in the Himalayan districts, ranging from Munneepore round to Cashmere, there are sites for 50,000 tea-farms, each occupied by an English yeoman and his retainers. This is exclusive of tea-farms in other districts. Coffee-planting would likewise give great employment to English principals and assistants.

In a military point of view the Simla group is of value, not only as commanding the doabs on the upper Gangetic valley, which it can reach from their heads at periods when no march can be made across the swollen rivers, but, if rightly treated, it is one of the keys of our dominion.

In the Punjab government, we have to strengthen our hill garrisons so as to provide against any excesses of the tribes, to guard against any attempt from Affghanistan, and above all to protect our empire against Russia.

The most effective protection, next to an army of English troops, is a strong reserve in the hills. No one in former times could ever contemplate with satisfaction the prospect of meeting the armies of Russia on the frontiers of Central Asia, or even in the regions of the Punjab, with such troops as our late native army. For this defence alone, we ought to keep a strong English army in India, and with our settlements well held by militia and volunteers, every battalion and every battery could, by railway, be concentrated within a week on the north-western frontier.

To strengthen that frontier, we must occupy as settlements the up-countries of Kangra and Lahoul, and we must repair the mistake of alienating Cashmere, by giving its ruler an appanage elsewhere. With the resources of Cashmere turned to profit by an English population, we should have the mastery of the Punjab secured to us.

The subject is no novel, so vast, and so comprehensive in its details, that it cannot be treated completely in one memoir; it is only possible, briefly, to indicate some of the topics for investigation. Thus, there should be considered, the raising of short-service English hill corps to feed the immigration, the formation of canon foundries, gunpowder works, and small-arm factories, the employment of native corps and officers on the principle of highland regiments, the residence of officers' wives and families in the hills, the provision for English soldiers' wives and children in the hills, the greater encouragement of marriage among the soldiery, the grant of lands to veterans and invalids, the organization of corps of military pensioners, the foundation of local corps of volunteer artillery and riflemen, the increase of English militia in the cities of the plains, by the removal there of settlers from the hills, the strengthening of the police by retired soldiers trained in the native languages, the provision of employment on public works for soldiers in the hills, as set forth in the memorandum of Sir John Login, the removal of all soldiers' children from the plains to the hills, according to the recommendation of General Tremenheere; the arrangement of constant relief from the hills, of all troops detached in garrison in the plains.

The whole operation, it will be seen, will be to a great degree self-supporting. The military expenditure of India which is now disbursed in the plains, would in the hills form the most effective encouragement to settlers, by opening to them markets for their produce, as has been the effect at the Cape of Good Hope, in New Zealand, and elsewhere on a smaller scale.

APPENDIX.

Note on the Healthiness of the Bengal Stations.

Although the hill stations have, from the causes so well stated by Mr. Grant in the first volume of The Calcutta Medical Journal (Mr. A. Grant on Hill Diarrhœa and Dysentery), certainly failed to answer the great expectations formed of them, it is impossible from the numbers in the accompanying Table to arrive at any just conclusion as to their healthiness; for regiments are usually sent there after being decimated by sickness: and when, at the end of a year or two, the constitutions of the men

have somewhat rallied, the exigencies of the service require them to return to the plains, to make way for others, who have in turn been prostrated and rendered inefficient, by the fever and dysentery of Lahore or of Peshawur.

The Table tells its own tale; the different stations being given in the order of their healthiness, commencing with Rawul Pindee, which presents the lowest rate of mortality, and ending with Cawnpore, the place most fatal to our European soldiers. The lowest is $2\frac{2}{4}$ per cent., to $1\frac{1}{4}$, the average for infantry in the United Kingdom during the 10 years ending 1846, as stated by M. Boudin. The Punjab contains, it will be seen, in Rawul Pindee and Lahore* at once the healthiest and the least salubrious but one, of all our Bengal cantonments: and as connected with that country one cannot help remarking the enormous proportion of admissions to hospital at Peshawur, viz., 352 per cent of strength. This is owing to fever, the prevalence of which is probably due to three principal causes: to the proximity of a large jheel, and the numerous rivers in the Peshawur valley; to the great range of the thermometer at most seasons of the year, especially in the months of September and October; and to the severe duty required of the men.

Of the hill stations, Dugshai shows by far the smallest proportion of deaths—not quite 3 per cent. The average number at Kussowlee—$4\frac{1}{2}$—was just as great as at Meerut or Benares, which were indeed the healthiest of our old stations, while at Subathoo the ratio of deaths rose nearly 2 per cent. higher, or, to from $\frac{1}{2}$ to 1 per cent. above that of Agra, Chinsurah, or Dum Dum. After making all due allowance for the previous sickliness of the regiments sent there, it is evident that the site itself cannot be sufficiently elevated, or that there must be something faulty in the barracks, to account for the low place it holds in our list.

* The unhealthiness of Lahore is probably caused by the action of the sun (so peculiarly powerful in that country) upon the overflowings of the Ravee. Malaria is thus generated and borne by the wind in the direction of the cantonment.

TABLE

Intended to show the COMPARATIVE HEALTHINESS (for EUROPEAN TROOPS) of the PRINCIPAL STATIONS in the BENGAL ESTABLISHMENT.

Stations.	Period of Observation.	Strength.	Treated.	Died.	Treated per 100 of strength.	Deaths per 100 of strength.
Rawul Pindee	6 years ending 1854-55	5,468	9,952	151	182·	2·76
Jullunder	9 „ „ 1854-55 *	7,163	11,731	205	163·77	2·86
Dugshai	5 „ „ 1854-55	4,227	7,494	126	177·28	2·98
Kussowlie	11 „ „ 1854-55 *	7,397	12,267	305	165·86	4·12
Meerut	9 „ „ 1852-53	15,915	33,038	766	207·59	4·12
Benares	9 „ „ 1852-5	1,372	3,053	58	222·	4·22
Agra	9 „ „ 1852-53 *	7,638	16,069	385	210·38	5·04
Chinsurah	26, 27 and 7 years ending 1837,†	6,531	9,288	332	141·29	5·08
Dum-Dum	9 years ending 1852-53 *	3,885	7,861	210	202·34	5·40
Subathoo	11 „ „ 1854-55 *	6,492	11,612	384	178·86	5·91
Umballah	11 „ „ 1854-55 *	19,137	37,342	1,162	195·12	6·07
Dinapore	9 „ „ 1852-53	8,733	16,510	542	189·	6·20
Ferozepore	11 „ „ 1854-55 *	8,918	19,399	566	217·51	6·34
Peshawur	6 „ „ 1854-55 *	14,867	52,321	269	351·92	6·51
Berhampore	1823 and 9 years ending 1834 †	11,077	22,156	763	200·01	6·88
Fort William	9 years ending 1852-55	6,426	12,049	450	187·50	7·
Lahore	9 „ „ 1854-55	15,289	41,861	1,153	273·79	7·54
Cawnpore	9 „ „ 1852-53	8,797	23,572	687	267·95	7·82

* Year 1849-50 not included.

† Col. Tulloch, quoted by Martin on Tropical Climates, p. 73.

Friday, February 4th, 1859.

LIEUT.-GEN. SIR WILLIAM CODRINGTON, K.C.B., M.P., in the Chair.

ON THE ORDNANCE SURVEY.

BY COLONEL JAMES, R.E., F.R.S., &c.

I AM afraid you will find this a very dry subject, but I will endeavour to go rapidly over the various points, more with the view of giving a correct outline of the whole proceedings and history of the Survey, than of going into minute details, which would be more adapted for a book than a lecture.

The history of our Survey presents a most remarkable example of that gradual and slow developement of just views which we often witness on other questions in this country; and as there has been so much discussion, and so many changes in the orders which have been issued from time to time respecting it, I have gladly availed myself of this opportunity to explain to the Officers of the Army and Navy, and the public generally, the exact state of the question at the present moment.

The survey commenced under General Roy, R.E. in 1785; but the object then in view was simply the production of a military map on a 1-inch scale, and that survey, with considerable interruption, consequent upon the wars then going on, had extended in 1824 from the Land's End to the boundary of Yorkshire and Lancashire, including the whole of Wales. It was then decided that there should be a general valuation of Ireland, and that, as a necessary basis for that valuation, there should be a townland survey; Ireland being divided into smaller divisions of parishes than England, called townlands, which are generally co-extensive with private properties, averaging about 300 acres each.

The whole survey force was then sent to Ireland, and the survey of Great Britain was altogether suspended. We commenced first in the North of Ireland, I myself taking part in the survey. To obtain accurately the acreage of the townlands, which was at first supposed would be all that would be required, it was decided that the scale should be six inches to the mile; and then commenced that series of mistakes which has interfered with our proceedings up to the present day. For no sooner had we completed the survey of four counties, according to our instructions, than it was found that the skeleton plan, containing the mere boundary of the townlands and the principal roads and rivers, was altogether insufficient; and that every field and garden must be surveyed to enable the tenement valuation to be made. We had consequently again to proceed to the North and complete the survey, and we have hardly completed it yet, having to put in every single field through the northern counties of Ireland. Our parties are now finishing it—they are in Armagh, and have nearly completed that county; and, when that is finished, I trust it will close the six-inch survey of Ireland. But the mistake and


ISLANDS
Trevose
13 Hensbarrow
Goonhilly Down
SCILLY ISLANDS
St Agnes
Redman
Lizard
Barrow Hill
Week Down
Bodmin Down
Par Valley
Scale of Geographical Miles

its consequences do not end there. Under the newly-constituted court, which was called the Encumbered Estates Court, and which is now called the Landed Estates Court, a vast amount of property is being constantly sold ; and for the purpose of sale they require accurate plans of the property. When you bear in mind that on the six-inch scale sixteen acres occupy one square inch only, you will understand how inadequately represented upon that scale were the small sub-divisions of property. By a curious coincidence, just as a royal commission on the survey had recommended the 25-inch scale for the survey of Great Britain, the judges of the Landed Estates Court in Ireland made an application, which has received the sanction of the Treasury, for the introduction of the 25-inch scale for Ireland, for the plans of all estates sold under the Landed Estates Court.

The survey of Ireland was completed on the six-inch scale; and, although it is to be regretted that it was not made in the first instance on a much larger scale, still it was found to be of such immense benefit as compared with the one-inch, that, when we resumed the survey of Great Britain in the North of England and South of Scotland, we were ordered to proceed upon the six-inch scale, as we had done in Ireland; and we completed the whole of Yorkshire and Lancashire, and several small counties in the South of Scotland on that scale. After we had completed Yorkshire and Lancashire, and several of the counties in Scotland, there commenced a discussion upon what was the proper scale for the plans, which, if it is quite closed, has only just been brought to a close; a Royal commission, composed of many of the most distinguished men of the day, of which Lord Wrottesley, President of the Royal Society, was Chairman, having unanimously recommended the adoption of the 25-inch scale as the national scale for our cadastral survey.

With these preliminary observations, I may proceed to describe the operations of the survey itself. The first requisite for a survey is, of course, a triangulation. When I say a survey, I speak of the survey of a great kingdom, not of a limited district. It is absolutely necessary that you should have an accurate triangulation. And, as a preliminary to obtaining an accurate triangulation, you must have accurate bases measured.

Plate I. represents the triangulation which we have carried over the whole of the United Kingdom, from the Scilly Islands to the Shetland Islands. The bases that have been measured, and from which all the distances in that triangulation have been computed, were those on Salisbury Plain, at Lough Foyle in Ireland, Misterton Car in Nottinghamshire, Rhuddlan Marsh in the North of Wales, and Belhelvie in Aberdeenshire. The two first were measured with Colby's compensation bars, the others with steel chains 100 feet long. (Plate II. fig. 1.)

The compensation bars for the measurement of bases, which were designed by the late General Colby, are made in this way: a bar of brass, A B, is firmly connected to an iron bar, C D, at their centres; these are again connected at each end with two iron tongues, E A, F B, moveable on pivots. On the projecting portions at E F a fine dot is made on a piece of platinum, and it is so arranged that the distance from the dot to the centre of the pivot at C shall be to the distance of the same dot to the

centre of the pivot at A in the ratio of the expansion or contraction of the iron bar C D, to the expansion or contraction of the brass bar A B. By this arrangement it will be seen that the distance between the dots at E and F remain at the uniform distance of 10 feet under every change of temperature.

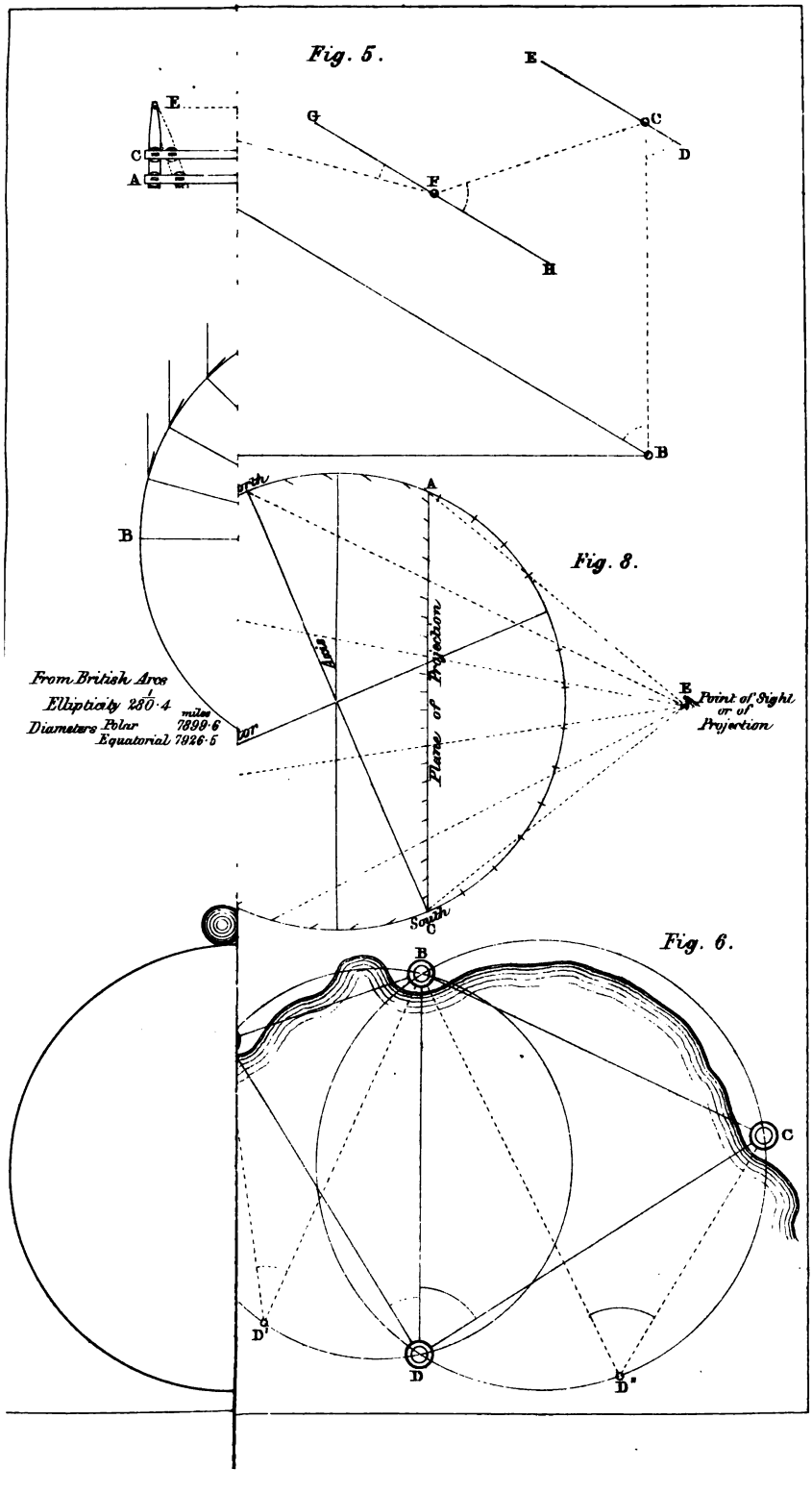
These bars, in the actual measurement of the bases, are laid perfectly horizontal by means of levels, and ranged in a perfectly straight line by means of sights upon them, and a directing telescope.

To prevent any disturbance in the position of the first laid bar, when the next to be placed in its position is brought up, a double microscope (like an opera glass, the distance between the foci of which is exactly 6 inches) is placed on the end of the bar about to be laid in position; by this arrangement the first laid bars are never touched or disturbed, and the exact distance of 6 inches between the foci of the microscopes is preserved by compensation bars on the same principle as in the 10-foot bars.

Mr. Babbage and Sir John Herschel were present when upon Lough Foyle 500 feet of part of the base of seven miles were remeasured, and, testing it by the finest dot that was made with the point of a fine needle, it was found to be only the third of a dot in error; such was the extreme accuracy with which the operation was carried on.

It is of little consequence to obtain extreme accuracy in one portion of a work unless we obtain the same accuracy in every other portion. The horizontal angles of the triangulation, as well as the vertical angles and azimuthal bearings of the stations, were measured with theodolites 3 feet in diameter. These magnificent theodolites were made by the great Ramsden, who made one for the Royal Society and one for the Master-General of the Ordnance. They were the first instruments which measured the spherical excess. All the angles in the triangulation having been observed, we had to encounter a most formidable question, namely, the correction of the observed angles so as to render the triangulation perfectly consistent in itself; that is to say, so that the sum of the three angles in every triangle should be 180°, and the sum round every station 360°: to do that required a mass of calculation perfectly astounding; and, bold as the Russian engineers are in undertaking such questions, they were astonished when told that we had overcome the difficulty. The calculations which we had to make involved the solving of equations with thirty-six unknown quantities. For my part I have always considered *thres* to be enough for a man with a moderate appetite for figures. The result of the triangulation has been this: By computing through the triangulation the length of one base from the other, and comparing the computed length with the measured distances, we found a difference of only 5 inches, the interval between Salisbury Plain and Lough Foyle being from 300 to 400 miles; and, when we compared the computed with the measured length of the base in Aberdeenshire, there was a difference of not more than 3 inches. Therefore we have a perfect moral certainty that we have a triangulation (which is the essential basis of accuracy) determined with a perfection which was never before attained.

We now come to another important point. It is also absolutely necessary that we should accurately determine the figure and dimensions of


Fig. 5.
E
C
A
G
F
H
B
Fig. 8.
North
A
B
East
West
From British Arcs
Ellipticity 250·4
Diameters Polar 7899·6 miles
Equatorial 7926·5
Plane of Projection
E
Point of Sight, or of Projection
South
C
Fig. 6.
B
C
D
D
D

the earth. Suppose you have a globe that is scored over with meridians and parallels. If a triangulation like a network is placed over it, you will understand that, if the globe is either too large or too small, the points of the angles will not reach their required latitudes and longitudes; and therefore it is absolutely necessary, in extensive surveys, that we should get a perfect knowledge of the figure and dimensions of the earth. From our own series of triangles we computed the 10 degrees between the Shetlands and the Isle of Wight. If we multiply that by 36, we get the circumference of the globe, supposing the earth to be a perfect sphere. If it were a perfect sphere, every degree of latitude along a meridian would be of equal length. But we find, if we measure a degree of latitude in the South of England, and another near Edinburgh, and another in the Shetland Islands, the degree is 100 yards longer at Edinburgh than at Southampton, and 200 yards longer in the Shetlands; this is caused by the ellipticity of the earth or the flattening at the poles. (Plate II. fig. 2.)

On the diagram (fig. A, B, C,) is the section of a perfect sphere, and the distances increase uniformly with the latitudes. But on the other side of the diagram, A, D, C, is the section of an elipsoid, and you will see that the distances for equal latitudes increase towards the poles; by the law of this increase we are able to determine the nature of the curve that is followed. The earth has an ellipticity of $\frac{1}{304}$, the polar diameter of the earth being 7899·5 miles, and the equatorial diameter being 7926·5. In this investigation we meet with a great difficulty, arising from the local attraction of the mountains which surround the stations at which the observations are taken. If for instance we take points north and south of Arthur's Seat, the attraction of the mountain would draw in the plumb-line towards it. This is made sensible by the levels attached to the instrument, the observed difference of latitude between the two stations being greater than is due to the distance along the meridian. Having eliminated the errors arising from this cause, we can determine the true figure of the earth, and we also obtain the data for determining the density of the earth, we can find the specific gravity of the mountain, and we know that the force of its attraction is in proportion to the mass, and in the inverse ratio of the square of the distance. So again the attraction of the earth itself is in proportion to its mass, and in the inverse ratio of the square of the radius. The ratio of these two attractions gives us the tangent of the angle of deflection in the plumb-line. If you suppose the mass of Arthur's Seat to be in the form of a small globe (Plate II. fig. 3), whilst this large globe represents the earth, then the plumb line, instead of going straight to the centre of the earth, will be drawn in the direction of the smaller globe. The result of this investigation is, that the attraction of the mountain was found to be about one-half only of what it would have been if it was of the same specific gravity as the earth, and that, the specific gravity of the mountain being 2·75, the specific gravity or mean density of the earth is 5·316.

The larger triangulation, the sides of which are about 100 miles long, having been established, it was subdivided into smaller triangles of about 10 or 15 miles a side. The triangulation being completed, the "detailed survey" is commenced. In the organisation of the survey, the work is

divided into several branches of which the triangulation which I have been describing forms the first; then follows the levelling, then the detailed survey, which I am about to refer to, then the preparation of the manuscript plans, and their final publication.

The whole survey force is 1,500 men, in which four companies of the Royal Engineers are employed, forming a military nucleus which keeps all in order. This force is divided into sections for each branch of the work. In fact, we carry out the subdivision of labour to as full an extent as a manufacturer would in any other department of work, and we find great benefit to arise from this system. We find also that we can now advantageously, and at a great reduction of cost, introduce the system of piece-work, and we have recourse to it wherever the nature of the work admits of its adoption.

I speak in the presence of many gentlemen in the Army and Navy who are familiar with the ordinary modes of surveying, and to whom it is unnecessary to describe many things I am about to refer to. But, as the sailors say, to keep the convoy together we must regulate our rate of going by the slowest ship. The system of survey which we prefer, when practicable, is to give a man a triangle, or half-a-dozen triangles; he chains along the sides of each triangle, leaving piquets upon the lines as he proceeds in such positions as he thinks most convenient for taking the detail of the survey. Our reason for this is, that, having computed the distances from our base line, we know, to the fraction of an inch, what the length of each side is, and when we see the field-book brought in, we can tell whether the chaining of the three sides is accurate, and when we lay down the work on the plan, it will be seen that the cross lines will not fit into their places, unless they are also of the exact dimensions that they should be. Therefore, although we do not watch the proceedings of the surveyor, we have a most thorough check upon the quality as well as the quantity of his work. (Plate II. fig. 4.)

This mode of surveying, viz. by chaining all the sides of the triangles, and a great number of internal lines, all connected with the sides, is the method we employ for the survey of the cultivated districts. The method we employ in the uncultivated districts, and which we must employ in the highlands, where it would be impossible to chain the sides of the triangles in the way I have described, is what is called traverse surveying.

In surveying by traverses along the course of streams or roads, the theodolite is employed, and is first put up at one of the trigonometrical stations, and one of the sides of the triangle is taken as a meridian to work from. (Plate II. fig. 5.)

The theodolite being placed in the direction of the meridian, B A, the bearing of the first station, C, in the traverse is observed; then clamping the instrument, and chaining the line B C, set up the instrument again at C, with the plates clamped, and after clamping the underplate, release the upper and take the next forward angle to F, and so on through the whole traverse. By following this course, the bearings are always taken in reference to the direction of the line taken as the first meridian, because the first observed angle, A B C, is equal to the angle B C D, in which position the instrument has been placed at C, and the line E D is parallel to the line A B, from which we started. A similar system will be pursued

at all the other stations, and when the traverse is closed at A, the angle B A F, if no mistake has been made, will be equal to the last observed angle A F G. The surveyor, therefore, has the means himself of knowing whether any error has been made in the angles during the course of the traverse.

Another mode of checking the work, and which enables us to say in what part of a traverse any error may have been made, is analogous to that adopted by sailors for fixing the position of any object near the coast. If he has three points, as A B C, (Plate II. fig. 6,) determined on land, by taking the two angles which A B, B C subtend from a boat at D, he fixes his position, because there is only the point D where the two circumscribing circles intersect each other, from which they could have been observed. By taking the bearing of the trigonometrical station, the traverse surveyor fixes his position in like manner, and provides checks for his work as it proceeds.

I will next refer to the levels. The datum level assumed for the survey is that of mean tide. (Plate II. fig. 7.) The tides, from high spring tides, continue to descend from day to day, till they come down to neap tide, again rising to spring tides; thus oscillating daily above and below the level of mean tide, which is the datum which we take, and all our levels are referred to that point. We take tidal observations at a great number of places all round the coast, and level along from one to the other; we thus establish a series of levels, which again become points of reference for branch lines of levels in every direction. These again become the initial points from which contours can be set off, and the data obtained for making a model. An ordinary survey gives the plane surface of the ground only, but a contoured plan gives the data for a model, for it gives us the relief also.

Having described our methods of surveying, we must refer to the series of maps which the Royal Commissioners have recommended the Government to adopt, and which, subject to the approval of Parliament, we are ordered to go on with. For towns we have the large survey on the one five hundredth scale, 500 feet being represented by 1 foot, or 42 feet by 1 inch.

For the parishes we have the 25-inch scale, which has been so much discussed. The 25-inch scale, which is equal to 1 square inch to an acre, is limited to the cultivated districts.

For the uncultivated districts of the counties, the scale is 6 inches to the mile, the 25-inch plans of the cultivated districts being reduced to the 6-inch scale, so as to complete the counties on one uniform scale.

We again reduce the 6-inch plans to the 1-inch scale, to form the ordinary 1-inch map. Therefore, for certain portions of the country we have four scales. One great object in having this series of plans is to carry into effect that great measure which I believe to be most important for the agricultural and commercial interests of this country, namely, the facilitating the transfer of property. It is a question which, as I see by Her Majesty's speech from the Throne, is now at the commencement of this session to be taken up by the Government.

I propose now to explain the manner in which we make the reductions of the plans by photography. Having that series of maps to make which

I have described, it would be the most tedious and expensive thing imaginable, having the large plans upon the 25-inch scale, again to replot the 25-inch to form the 6-inch, and again to replot the 6-inch to the 1-inch, it being at the same time necessary that everything should be represented accurately. Seeing the enormous amount of labour involved by the whole process of reduction by the pentagraph, I directed my attention to the possibility of getting some other method; and, although I was at first discouraged by the photographers whom I consulted, I have now entirely succeeded by means of photography, and I may say with absolute accuracy; for a commission, of which Sir Roderick Murchison was chairman, has investigated the subject, and it is stated in the report that the greatest error is the one four hundredth part of an inch; therefore, practically, we may consider the reduction as being absolutely correct. In making the reductions we use the ordinary collodion process. [*Several of the negatives were here exhibited, as well as a great number of positive impressions which were produced from them.*] In some instances several sheets have been joined together, and by the manner in which they join, it was evident that they were perfectly accurate, for if they were not so, the lines would not correspond. The success which we have achieved is, perhaps, more important as a question of time than of money; for the question was, how it was to be done at all, so as to get out the maps in any reasonable time; we now find that by the aid of photography we can strike off any number that may be required in a short time, and without the slightest difficulty. With regard to the saving of money, it saves us at the present moment, in wages merely, upwards of £1,600 a year; and if the survey should be continued on the large scale, it would save £32,000, or not less than £40,000 in all.

The next thing was to introduce an expeditious mode of publishing the plans on a large scale. We first tried the system of lithography, but we eventually determined to try zincography. In the first place, the lithographic stones were enormously expensive; secondly, they were of tremendous weight, being several hundredweight to lift; and, what was still worse, when they had cost us £4 or £5 they frequently broke. We therefore determined to try zincography. In that attempt we have succeeded beyond all expectation; and I take no credit to myself for it, because I have been assisted by intelligent non-commissioned officers and others who carry out one's ideas in a manner most gratifying to me as superintendent. [*A small press was here exhibited to show how the operation was performed.*]

Colonel James then proceeded: I should have explained before, that Corporal Neil has placed in the press a thin piece of tracing paper, which is laid over a plan and traced; all the figures referring to the fields, the acreage of which is given, are put in by mechanical means; not only is that done upon the tracing, but it is also done upon that which may be called the manuscript map. We have electrotyped the stamps, and the result is, that when the plans come in from parties stationed in different places, as at Perth, Newcastle, and Carlisle, for instance, you cannot tell one from the other—Corporal Neil has one of those tracings. You will see in a short time that he will produce a plate: the impressions will

not be quite perfect at first, but if you want 500 they will improve as they go on.

After we have reduced the plans by photography, it is necessary to engrave the 6-inch sheets upon copper. It is so arranged that 16 of the reductions exactly cover the area of one of the sheets of the 6-inch survey, and therefore the reductions can be brought into their exact positions by placing the tracings from them over the marginal lines and trigonometrical stations as drawn upon the copper plate. The engraved work is cut into the plate; but we have introduced a great number of mechanical contrivances, as for making the letters, stamps for the trees, and ruling machines for the tints, and so on, which economizes the labour of engraving; the result is, that we produce the plates from which the impressions are taken as you now see them, and at a very much diminished cost as compared to what it was formerly.

We now come to the sketching of the ground. We take the 6-inch impressions and put them into the hands of the field-parties to sketch the ground on. It was useless labour to make a reduced copy in manuscript when we had the engraved plan which we could give the men, and therefore we use the engraved impression. The ground having been sketched by the field-sketchers, as we term them, a drawing from the field sketch is next made on an outline impression on the 1-inch scale, and from that is engraved the 1-inch map which the public receive. You will observe the necessity of having the intermediate hill drawing, which requires a very first-rate artist to draw: this is a step which we should be very glad indeed to get rid of, and I have had a great number of experiments made with a view of effecting that object, and to get a copy by photography of the original sketches, straight down upon the plates, without the intervention of that drawing. I have here four experimental sheets intended to be sent to India, and I think we have in that trial sheet alone a pretty good proof that we shall succeed.

Any gentlemen who have examined the old sheets of the map of England must have observed how very much the plates have been worn in printing, and it has been a source to us of constant expense, and I may say of shame, to be continually repairing our plates and giving to the public very damaged and bad impressions. We now get rid of the whole of that difficulty. As soon as an original plate—of Edinburgh for example—is engraved, we put it in the electrotype battery (Smee's battery). Upon that original engraved plate we throw down by the battery a plate which is called the "matrix," and which is therefore in relief, and then again we throw down another plate upon the matrix which is the exact duplicate of the original plate; and so, for the mere expenditure of zinc and acid, we are enabled to produce any number of exact duplicates of the original plate. It is impossible to exaggerate the advantage which this has been to us. In the first place Sir Roderick Murchison, for example, requires a special map for his geological survey, and we take a plate for geology, leaving our original plate untouched. Again, we require indexes to the counties, examples of which are on the wall, and we take another plate for them. The indexes to the survey are by counties, whilst the engraving of the

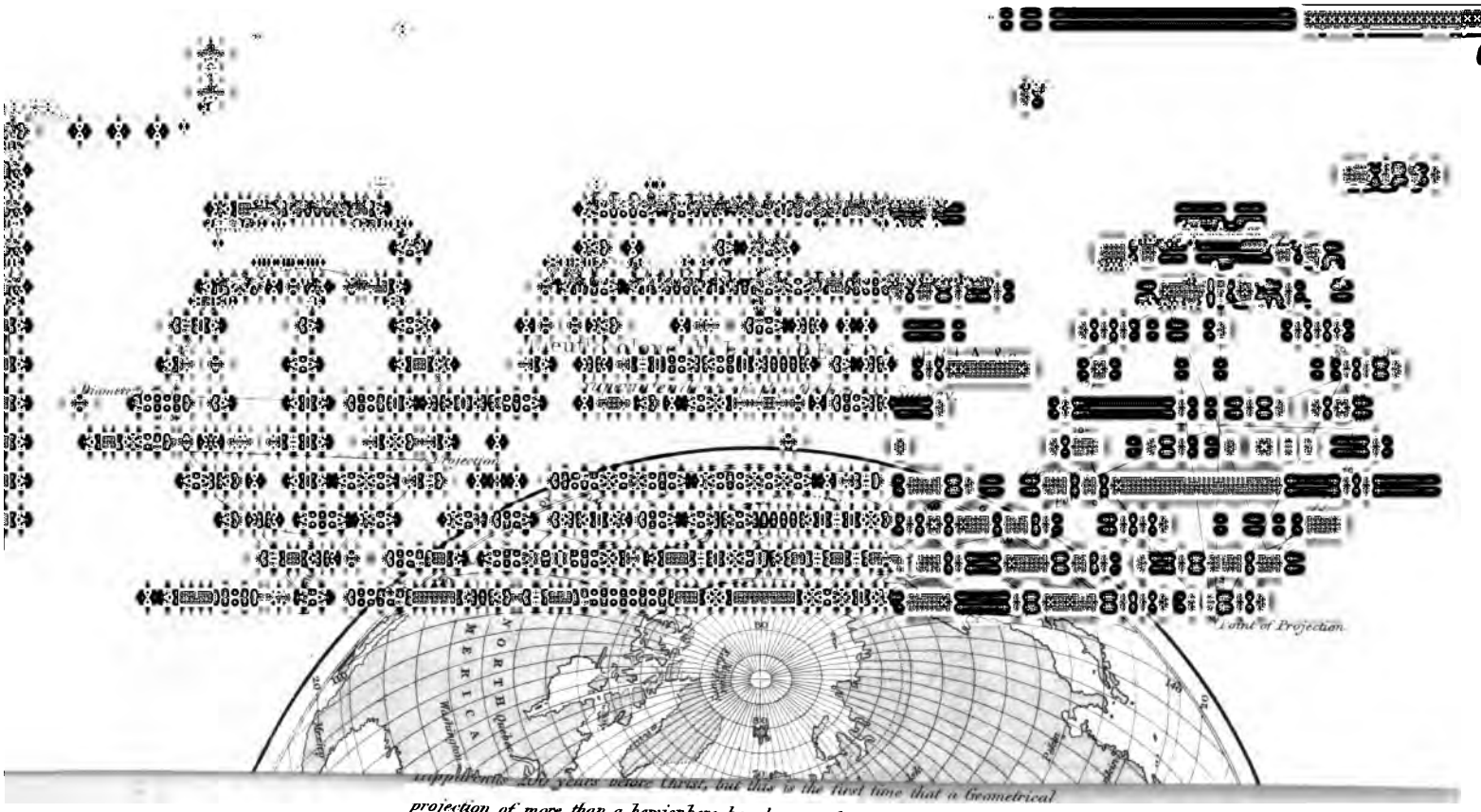
1-inch map is by rectangular sheets. To make the indexes, we simply cut out those portions of several matrixes which would form one county. These several parts are then put together, and the electrotype copy taken, we are thus enabled to bring out the county map, which is a most beautiful engraving, and yet the hand of man has never touched it.

The accuracy with which these duplicates, made by the electrotype process, are made, and the manner in which the metal finds its way into every crevice of the engraving, is to me one of the most wonderful things I know of, and the more I contemplate it, the more astonished I am; if you take a microscope and compare the duplicate and the original, not the slightest difference can be discovered between the two. But still more astonishing is the process called acierizing, by which a steel surface is put on the copper duplicate, the object being to prevent the wearing away of the plate under the printing operation. We have examined the impressions from the acierized duplicates, and we cannot, even with the microscope, find any difference between them and the original. When we consider how extremely minute the particles or atoms of metal must be, to produce such a result, it is quite wonderful.

I think I have given you an outline of nearly all of our operations. It could only be an outline in the time allowed for a lecture of this kind; but I trust it will be sufficient to shew you that the survey has assumed a character altogether different to that from which it started, and altogether different to that which it had assumed in the south of England. Our large-scale plans have been hitherto confined to the north of England and to Scotland. And when we hear gentleman saying that this large scale is an abominable Scotch job, I may remark that we had done a great deal more in England than in Scotland on the large scales. We have never made any distinction between the surveys of England and Scotland; it was the survey of *Great Britain* which was going on. We have now large parties stationed in Cumberland and in Northumberland, and we shall have made great progress in those two counties by the end of this year, so that we shall shortly be able to close the gap which now exists between the surveys of England and Scotland.

With regard to the estimates for this work, we have this most surprising result from the different changes which we have made in the mode of conducting the work, and the introduction of all those mechanical appliances which I have attempted to describe. We have reduced the estimate made by my predecessor, and which is published in the correspondence upon the survey in a Parliamentary Paper, and find that the actual cost (for it is not an estimate any longer) is less than one-half the cost at which it was originally estimated. It was estimated by Colonel Hall at 2*s.* an acre, and we have reduced it to 11½*d.*, but I will stick to 1*s.* to provide for contingencies. The difference of the cost, however, is such, that upon the average annual expenditure upon the survey, it is equivalent to an annual saving of £60,000.

I have concluded the observations which I think it necessary to make with reference to the Ordnance Survey, but I have been requested by the Council of this Society to explain the nature of the projection of the sphere which I have made, and I shall be happy to do so, because it is likely to become a very useful one, especially when we want to embrace



projection of more than a hemisphere has been made.

N.B. The dark lines indicate the position of all the measured arcs of Meridians.

a large portion of the earth's surface at one view. The geometrical projection of the hemisphere, which is known as the stereographic (the earliest known projection of the hemisphere) was made by Hipparchus 200 years before the birth of Christ; but it is a curious circumstance that up to the present time it seems not to have occurred to any one to make a geometrical projection of more than a hemisphere. It is remarked by Sir John Herschel in his Outlines of Astronomy, that Falmouth is the centre of the hemisphere which embraces the greatest amount of land and the great centre therefore of men. In verifying this fact on a globe it occurred to me to inquire what would be the centre of all the land, and I found that a point in 15° east longitude and 23° 30′ north latitude, was the centre of a circle embracing Europe, Asia, Africa, America, and a part of Australia, including two-thirds of the surface of the sphere. The question was, how that could be represented. It seemed like an impossibility to do so, but it occurred to me that the difficulty might be got over by imagining we were looking into the sphere and not at it. The projection is made in this manner; the eye or point of projection E is at the distance of half the radius from the sphere, A B C is two-thirds of the sphere, and A C the plane of projection, on which from the point E all the interior surface of A B C would be seen. (Plate II. fig. 8.)

By adopting the position shown for the axis of the earth, I get the north pole or the south pole, as it may be, at the limit of the projection. Many gentlemen who have seen these projections, and Sir Charles Lyell and others, have said that it is the first time they ever thoroughly understood the relation of one part of the earth to the other, for you cannot see it by looking at a globe or at Mercator's projection; and if you attempt to get it from the two hemispheres, your eye is thrown out, and you cannot comprehend it; but in this projection (Plate III.) you get everything round the poles, and you see the accurate relation of one part to another. Upon this projection I have laid down what are called the lines of equal magnetic declination, and you will see how all those lines converge upon the magnetic pole, and upon the true pole of the earth. I have a similar projection for the southern regions and the Pacific Ocean; and we have also applied it to the projection of the stars. In this latter case it is essentially like looking into the vault of the heavens; and instead of a representation by six separate plates, as you have in Sir John Lubbock's gnomonic projection, you have two-thirds of the sphere represented at once. This projection is also particularly well suited for the representation of the isothermal and isobarometrical lines for exhibiting the direction of the winds and currents, and, as I have before said, all the great physical facts for the comprehension and exhibition of which we require to have before us the greater portion of the earth.

[*Corporal Neil struck off, during the lecture, some impressions from a zinc plate, which were exhibited, and which are now deposited in the topographical department of the Institution.*]

This mode of preparing a plate for printing is exactly the reverse of the engraving process. In engraving the engraver cuts into the copper, and the ink is rubbed in previous to taking the impression; but in this process the tracing of the plan, traced with greasy ink, is laid on the zinc; the grease of the ink coming in contact with the surface of the zinc

adheres to it; a very weak solution of gallic and phosphoric acids is then applied, which acts upon the exposed part of the plate, while the oil of the ink preserves the plate where there is any writing or drawing. The effect is that the bitten portion will not receive the ink, and the unbitten or greasy surface will, as in lithography.

You see the importance of having a simple, expeditious, and inexpensive mode of producing this 25-inch map, by which it is brought home, so to speak, to the door of every man, for little more than the value of the paper. We are able to strike the impressions off at the rate of 1,000 a day; and everybody buys when they can be got so cheaply. The Government does not seek to make a profit out of them; the survey has been paid for in the taxes, and therefore it lets the people have the copies as cheaply as possible. I advocated this strongly before the Committee of the House of Commons on the survey, though a great number of gentlemen said "No; make the survey and lock it up." The advantage of this process is, that it is so cheap that the sale of the maps covers the entire cost of the publication. And I will close my observations by saying that, whatever may be the case in other things, the public in this matter get their money's worth for their money.

Chairman.—Before we part, our thanks are due to Colonel James for his lecture. Instead of its having been a dry one, it has been very much the contrary. The subject is one which is becoming more and more important to financial as well as to military people. And I beg to tender our very cordial thanks to Colonel James.

ON THE IMPORTANCE OF A KNOWLEDGE OF THE ELEMENTS OF PRACTICAL SURGERY TO NAVAL AND MILITARY OFFICERS.

By WILLIAM HENRY FLOWER, F.R.C.S., Assistant-Surgeon to the Middlesex Hospital, formerly of H.M.'s 63rd Regiment.

ONE of the numerous branches into which the art of warfare is divided, has for its immediate object the destruction of human life, or, as it may more correctly and perhaps more humanely be defined, the infliction of such injuries as shall disable from further service. This terrible art has certainly held no backward place amid the onward progress which has characterised all departments of human skill and knowledge. Every successive war, nay, almost every year of peace, has added its quota of progress: even within this century, the general increase of the weight and force of the projectiles employed, especially the substitution of the heavy conical rifle bullet for the small round musket ball of the peninsular campaign, has added greatly to the severity and danger of the wounds received in battle.

With this resistless onward progress of the destroyer there has been marching side by side, less obtrusively it is true, but not less surely, a companion art, whose only mission is to alleviate the sufferings and lessen the devastation caused by the other. Almost paradoxical as it may appear, from the time that man first waged war upon, and begun to wound and kill his fellow-men, he has been ready to avail himself of all the knowledge and skill that could be obtained to save and to cure.

We are not, however, at present so much concerned with what may be done by those who are professionally engaged in the practice of surgery, as with what may sometimes be accomplished in the same direction by others.

Addresses have been occasionally given at this Institution upon the advantages of a knowledge of nearly every branch of science known to man, and I think that it is now generally admitted that the more varied and extensive any one's knowledge is the greater will be his powers of application to any particular science, and the greater will be his means of promoting his own happiness and that of mankind in general. This is especially applicable to those occupying the position of most of the members of this Institution, frequently led by their professional duties to situations remote from the resources and enjoyments, cares and distractions of busy life, but still surrounded with food for study and contemplation in the ever present and yet ever interesting, ever instructive works of nature. On these grounds alone the science of surgery in all its branches direct and collateral, including anatomy, which teaches the structure, and physiology, which treats of the functions and actions of the component parts of that wondrous work of God, the human frame, cannot be without interest to every mind endowed with powers of observation and reflection.

But setting such considerations aside for the present, and looking upon

the subject only in its more practical bearings upon the ordinary business of life, it is my purpose to show that there are cases in which, by a little knowledge rightly applied, something may be done towards alleviating the effects of those injuries to which all, but especially those who follow the honourable but dangerous professions of the soldier or sailor, are liable.

But here at the outset a timely warning must be given, that if any one with a smattering of knowledge were to think that he could replace the regularly-educated physician or surgeon, such knowledge would, indeed, be a dangerous thing. To a bystander it may seem a simple matter to dress a wound or set a broken leg, and the best of medical practice may be full of guesses and blunders and uncertainties, painful and humiliating to human reason; but yet many years of labour, reading, observation, and reflection are required to arrive at any tolerable amount of knowledge of this, which I may safely say is one of the most intricate branches of human study. Little indeed, painfully, miserably little, as is our knowledge of and power over disease, when measured by what the imagination would soar to or the heart desire, yet this little raises the educated medical man, when on his own ground, to an immeasurable distance above one who has never passed through the ordeal of a professional education, and places a bar between them which it would be folly to attempt to leap over. There is an amount of knowledge to be obtained by all which will never bring its votaries to this, but on the contrary teach them more fully to value and to appreciate, where they would never hope to supersede.

With the judiciously increased medical staff of both services, and the more general employment of surgeons on ships, in colonies, and rura districts, it can rarely happen now that proper aid cannot be obtainel before an illness is of any long duration; but, either in the peacefud occupations of exploring or surveying parties, or in the more dangerousl duties of skirmishing and foraging on land, or the gunboat service at sea, accidents happen in which early assistance is of momentous consequence. In such cases the immediate presence of a surgeon can rarely be procured; the poor sufferer placed, perhaps, by the carelessness or ignorance of those around him, in a position of agonizing pain, receives irreparable injury; it may be that his life's blood ebbs away for want of assistance, which it would be in the power of any of his comrades to render, if they had but a little previous instruction. Another important consideration is the satisfaction of not feeling hopelessly lost, of knowing something of the extent of the danger, and that such help as may be obtained is always at hand. The assurance that the presence of a surgeon gives, even where surrounding circumstances render his assistance of very little real value (as I had frequent opportunities of observing in the trenches before Sebastopol), is no mean thing; and the same confidence would doubtless prevail to a great extent, if men who were known to be capable of acting as surgeons in cases of sudden emergence, were to be found in every detachment of combatants, however small.

There will scarcely be time in the limits of this lecture to do more than glance briefly at the principal injuries which may be met with on such services as officers and men in the army and navy are liable to perform, and which may be relieved by prompt assistance from any tolerably skilful and sensible person. It is not intended to touch upon any but

accidents requiring *surgical* treatment; and it must be remembered that all that is said only applies to cases where no surgeon is at hand, and must not interfere with seeking his assistance.

It is well known that, whenever a wound is inflicted on almost any part of the body, bleeding, or as it is called in technical language, hæmorrhage, ensues. If this bleeding is of small amount, but little harm will come to the sufferer; but if, on the other hand, it be in very large quantity, or long continued, it will be the direct cause of the injured person's death. Hence, it has always been one of the first duties of those engaged in the treatment of wounds, to be familiar with the effects of, and also the means of preventing, loss of blood.

In order to render what follows intelligible, it will be necessary to make a brief physiological explanation. The blood, as most people are aware, is sent from the heart to every part of the body, through a system of tubes called arteries: a main artery runs down each limb, and gives off branches, which further sub-divide until they become a set of minute vessels called capillaries, invisible to the naked eye, pervading every tissue of the body in a most delicate network; these finally collect again into another set of vessels called veins, which, uniting together, end in the two main trunks which bring the blood back to the heart. We have then three sets of vessels from which bleeding may take place: first, the arteries, bringing blood direct from the heart, and which, when cut across, allow it to escape in a forcible stream, often spouting to a distance of several feet, and in a succession of jerks, corresponding to the successive impulses of the heart's action; secondly, the minute capillaries, of which hundreds are divided in every wound, and from which the escape is a mere general oozing of the cut surface; thirdly, the veins, in which the blood, darker in colour, and changed in properties, has lost the vigorous impulse derived from the heart, and runs slowly, so that a steady, but comparatively feeble stream, easily stayed by slight pressure, flows from a wounded vein. These are facts of great simplicity, a knowledge of which every one interested in the economy of the human body may readily acquire, but which are of the highest practical importance in the treatment of accidental hæmorrhage. From them we learn that it is not so much from the veins, nor from the capillary vessels, nor even from the smaller arterial twigs, but only when a considerable sized artery is divided, that we may anticipate severe and rapid bleeding, such as is likely to prove the immediate cause of death unless prompt assistance is at hand.

I believe that, as it was at one time the opinion among surgeons, it is still the impression among others, that loss of blood is the effect most to be dreaded, of wounds received upon battle-fields. But the more accurate observations of recent times, and an increased acquaintance with the natural processes by which bleeding is often arrested before life is extinct, even in extensive wounds, have led to a considerable modification of this idea. In fact, deaths arising from this cause are not very numerous, except in cases where some important part of the trunk, or some very large vessel is opened, in which case the blood would be so rapidly lost that scarcely any assistance would be of avail. The reasons that gunshot wounds of the extremities bleed less than almost any other kind of injury that can be inflicted upon them are curious, and depend upon some peculiar

properties with which arteries are endowed, apparently for protective purposes. One of these properties is great elasticity, which causes them to slip out of the way of a ball, instead of being wounded by it. Bullets may traverse a limb without injuring the great vessels, though apparently passing exactly through their course. Again, in wounds of a very different nature, those made by round shot or pieces of shell, extremely frequent upon the battle-field, the arteries are not cut, but torn across; and it is well known to surgeons that, when this happens, there is usually but little hæmorrhage. The fact is well known; its explanation would require more time than can be allowed in the limits of this lecture. Instances not unfrequently occur (I can recall several within my own experience) in which a limb is carried entirely away, leaving a ragged stump. The end of the great artery may be seen rising in the wound at each pulsation of the heart, but not a drop of blood issues from it, owing to the remarkable process by which, in such wounds, nature closes the breach almost as soon as it is made. Persons who have received such injuries usually die, not from loss of blood, but from the shock to the system, producing an amount of depression greater than the vital powers are able to sustain. If a wound so extensive were inflicted by the clean cut of a knife, blood would flow so rapidly that life would be extinct in a few minutes.

I mention these facts to show that the alarm that has been felt upon this subject, both by surgeons and wounded men, may to a great extent be set aside; but as there are undoubtedly cases in which bleeding does take place so freely as to endanger life, both in the above-named and other kinds of accidents, I will proceed to enumerate the readiest means for arresting it, which will be in the power of any one to adopt. In the first place, simple attention to position, the part being, if possible, raised above the level of the rest of the body, is a thing which should never be lost sight of. In carrying a wounded man to the rear, it may be useful to bear this in mind. One of the most efficient agents in repressing hæmorrhage is cold; it causes the open mouths of the little bleeding arteries to contract, and so prevents the escape of their contents. How frequently is it the practice to cover up wounds with soft warm dressings, to put on bandage after bandage, in the vain hope of staying the flow of the vital fluid; no treatment could be worse. Take away all the coverings, expose the wound freely to the air, or pour a stream of water as cold as can be procured upon it, and the work is done. Of the various substances employed mechanically or chemically to stop bleeding, known by the general name of styptics, I need say nothing here, as they are not of general application, and, except in hospitals, rarely at hand if wanted immediately. The same remark will apply to that most powerful agent the "actual cautery," or heated iron. For all slight cases the simple methods above mentioned will suffice. If an arterial trunk of any size is wounded and bleeding, nothing but the "ligature" of the vessel will make an effectual cure. This is done by seizing the cut end of the artery with the forceps or tentaculum (a sharp hook for the purpose), drawing it a little way from the surface of the wound, and tying a piece of silk firmly round it. This proceeding can of course hardly be expected from any non-professional person, but fortunately the same result can be

temporarily obtained by any method which compresses the artery, so as to obstruct the flow of blood through it, applied either at or above the wounded part. If this should be near to the heart, in the neck for instance, the bleeding point must be pressed upon with the fingers, and kept closed until assistance shall arrive. Should the vessel wounded be very large, and the hæmorrhage profuse, of course the means used must be proportionally prompt and effective. Baron Larrey* relates the case of an aid-de-camp to General Berthier, who at the siege of St. Jean d'Acre received a bullet wound in the neck which opened the main artery, the carotid. One of the gunners, a very intelligent man, immediately seized it with his fingers, and kept the wound closed until the surgeon arrived, and the officer's life was saved. Had there been any hesitation on the part of that soldier the result must have been different. Somewhat similar instances are narrated as having occurred in our own armies in India, by Hennen† and Cole.‡

When the wound is in one of the limbs, it will generally be more convenient to apply the pressure at some part of the extremity nearer to the *heart* than the wound, so as to cut off the flow of blood towards it. As has already been mentioned, a principal vessel runs down each limb, but there are also smaller communicating branches which keep up what is called "collateral circulation," so that even if the main pipe is obstructed or obliterated all nutrition of the extremity does not cease. Our object in applying a tourniquet is generally sufficiently accomplished if we can stop the flow of blood in the main trunk. Now as this vessel lies tolerably deep, and most of the returning venous channels are nearer to the surface, a simple bandage fastened round the limb, without any regard for the anatomical position of the parts, will be more likely to do harm than good, not arresting the flow towards the wound, but impeding its return from it, acting in fact just as the tape bound round the arm does in the operation of blood-letting. Hence, in every form of tourniquet that has been invented, or in the extemporized arrangements for effecting its purpose in the field, the great point aimed at has been to concentrate the pressure upon one particular spot, that where the artery runs, relieving it as much as possible from other parts. This object is effected by means of the *pad*, which, together with the *band* for encircling the limb, and the *means of tightening*, constitute the essential parts of the instrument. To know exactly the best points to apply the tourniquet requires a slight acquaintance with anatomy, but not more than any one may very readily acquire. It may be sufficient for the present purpose to indicate the inner side of the arm, about midway between the shoulder and elbow, and the inner side of the front of the thigh, about three or four inches from the top, as the best positions for the pad, as in these parts the bone, being beneath the artery, gives a firm support against which it may be compressed. The exact situation, which varies slightly in different persons, can always be ascertained by feeling for the pulsation of the vessel. The degree of pressure required is to be measured by the cessation of the bleeding, and of all pulsation in the arteries of the limb below the constricted part; and it must be remembered that the tightening process should only be con-

* Mémoires de Chirurgie Militaire, vol. i. p. 309.

† Hennen's Military Surgery, p. 180. ‡ Cole's Military Surgery, p. 121.

tinued till this effect ensues. If any unnecessary force is employed the soft parts of the limb may be severely bruised. As Hennen justly remarks, "Too great caution cannot be employed in guarding against superfluous and long-continued pressure, and the attendants, as well as the wounded individuals, should be warned to apply as soon as possible to the medical assistants, in order that they may examine the state of parts in which the circulation is confined."

The earliest form of this instrument in use is that called the "Stick Tourniquet," (fig. 1), said to have been invented by Morrell, at the siege of Besançon, in 1674. As it fully answers its purpose, can be made of materials almost always at hand, may be variously modified according to circumstances, and can be very readily applied, it is the one best adapted for emergencies. It consists of a band of webbing (a pocket handkerchief, brace, or scarf, will do as well,) (fig. 2) with a stuffed leather pad; in default of which, a pebble wrapped up in a handkerchief, or a cork, or any similar substance, will answer the purpose. The band is placed round the limb, and tied in an ordinary double knot, the pad being over the artery, while, for the sake of convenience in fastening, the knot is usually made on the opposite or outer side of the limb. Then a stout piece of stick, or anything else that comes to hand, the ramrod of a pistol, or a drumstick for instance, is passed through the knot, and turned several times round, by which means the band may be tightened as much as is required, and the pad pressed down upon the artery. One thing more is wanting to prevent the twisting of the knot hurting the skin over which it is placed. This was accomplished in Morrell's tourniquet by an oblong piece of leather, with slits cut near each extremity, through which the ends of the band were passed, the middle of the leather being interposed between the knot and the skin. In an extempore instrument, a piece of paper folded (fig. 2)

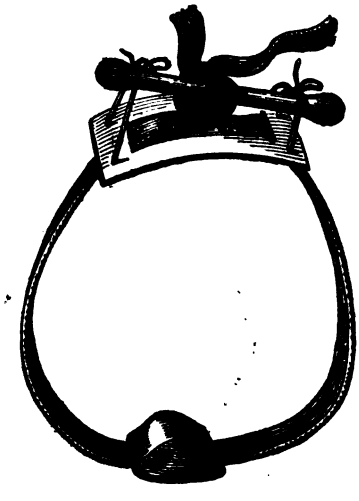


Fig. 1.



Fig. 2.

and placed under the knot will answer as well. When the stick has been twisted round sufficiently, it must be secured, to prevent its turning back and loosening the band. This is easily done by tying it with a little piece of twine or tape, or with the ends of the handkerchief, or whatever it is that encircles the limb.

Such instruments as these were in common use in our navy during the great war, especially for gun-boat service, the stick for fastening them, called a "toggle," being usually made by the ship's carpenter; it was a piece of tough wood, four or five inches long, and in each end, which was a little thicker than the middle (see fig. 2), a hole was drilled, through which a piece of twine could be passed, and made fast to the band that encircled the leg, or sometimes a tape attached to the leather was used to secure the end of the stick (fig. 1).

In the "field tourniquet" supplied to the army during the Crimean campaign, the band (a piece of webbing about two feet long and an inch and a quarter broad) was passed over two brass rollers, turning in a little frame, to the under surface of which the pad was attached; this being adjusted over the artery, the ends of the band were pulled as tight as possible and fixed by means of three spikes on each side of the frame. This instrument occupies very little space in packing; its disadvantage is that pulling by the hand is not always sufficiently powerful to produce the requisite degree of pressure, the "toggle" being in this respect far superior, and in most that were made the pad was much too small, at least for the thigh.

The "screw" tourniquet (fig. 3), now furnished with all regulation cases of surgical instruments, both to the army and navy, was invented by



Fig. 3.

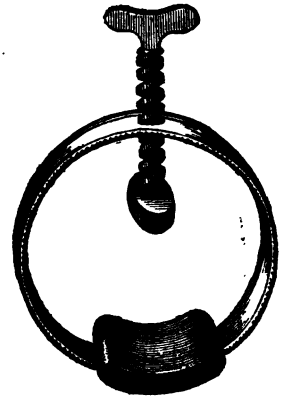


Fig. 4.

is on the whole one of the
nd. It consists of a band
, a pad, and an apparatus
nected by a screw. The
manner that, as they are
proportionally tightened.
he main difference being
not and stick as the con-
ification of this tourniquet
ead of projecting at right
ce when adjusted is less
displaced.

nds of tourniquets is, that
tly upon it in every part,
the veins. To remedy
he pressure is confined to
n the opposite side of the
' tourniquet (fig. 4), con-
with a large concave pad
nd a smaller pad for the
through the ring. When
is pressed down upon the
undoubtedly answer the
in which a band is used;
liability to get displaced
for field practice, where

hat have been invented, I
w as assisting to illustrate
e instrument is used. To
nd some slight anatomical
t be sufficient to serve out
's company or a regiment,
The steadiest and ablest
ve confidence—should be
instructions in it directly
ving at all—and that they
e no one will deny—it is
y to apply them in such a
are designed.

, especially when engaged
our bones. In order to
of treating "fractures," as
ntance with anatomy and
pected from any non-pro-
hould be known, and that
se injuries, where imme-
ch accidents, severe and
serious and agonising by
h the very best intentions

of those who afford assistance, the sufferer is carried with his limb dangling or rolling about to the nearest medical man." * Great and often irreparable injury is thus inflicted; a *simple* fracture—that is, one in which the bone is merely snapped across without any external wound—is often converted, by the sharp broken end being allowed to press through the flesh, into what is called *compound:* the former merely requiring a few weeks' rest to make an effectual cure, the latter often entailing months of suffering, sometimes causing the loss, or permanent impairment of the limb, and not unfrequently terminating in the death of the patient.

The first portion of the treatment of a fracture has such an important effect upon the ultimate result, that it is the duty of every one who by any combination of circumstances may be called on to practise it, to pay some attention to this subject; and the removal of wounded or otherwise injured persons to where surgical aid can be obtained very often falls to the lot of non-medical officers. In the first place, it is desirable to be able to discover whether a leg or an arm is broken. In ordinary cases this is not difficult—the patient is unable to lift up the limb, and in any attempt to do so by himself or others an unnatural bending and motion are seen at the broken part. If there is any doubt, too much care of course is better than too little. While seeking for surgical assistance, if the injury is in the upper extremity, simply slinging the arm in the position most comfortable, usually with the elbow bent at right-angles across the chest, will be sufficient, and a broad handkerchief, generally at hand, makes the most efficient sling. As fractures of the leg are generally attended with more danger, more care will be required in their management. If the patient has to be moved, be it ever so short a distance, he must be placed upon some sort of stretcher; if a proper one is not to be found, a shutter, hurdle, or an extempore one made by tying wooden poles, oars, or branches of trees together, with a piece of sheeting or blanket stretched over them, will do. The side poles of the stretcher should always be kept apart by traverses or cross-bars fixed near each end, otherwise the weight of the patient will cause him to hang in a very unfavourable position, and bring the poles together to the great inconvenience of the persons carrying them. A man with a broken leg should lie on a surface perfectly flat, and which will not yield to his weight. If there is any distance to go, it is as well to have two persons at each end, all of course keeping step. Hand-carriage in this way is always preferable to any other mode of conveyance, especially in rough countries, where the jolting of a waggon or cart is often insufferable.

Having placed the person on the stretcher, the limb must be laid as nearly as possible in its natural direction; for if the broken part be left bent, it is far from improbable that one or other of the ends of the bone will be thrust through the skin, and a compound fracture be produced. In order to avoid this, it is best to bring the sound limb alongside the broken one, and tie them together with two or three bandages or handkerchiefs; this will give great support, and prevent any movement in it. If further security seems desirable, splints should also be fastened to the

* Household Surgery, or Hints in Emergencies. By J. F. South.

urpose better than those
uently at hand than any
rist, and of the required
nd tightly round it. The

formed me of a plan for
cumstances might be very
h, branch of tree, oar, or
aid down beside him, and
with handkerchiefs, belts,
then lifted up and carried
dragged for some distance
ngle man. Rough as this
sions the means of saving

es dislocated or put out of
ury should be remedied as
thin a few hours the con-
to render the reduction of
often impossible. Disloca-
e shape of the joint, with
the direction of the bone.
er than any other joint, as
arms to save his face, and
is part. There are several
the readiest is to make the
round, then sit down beside
oted) into his armpit, grasp
until you feel the bone go
se the extension, bring the
eans of a bandage keep it
ill be apt to become again

e attended to, especially by
t of the different kinds of
&c., and also of bruises
he mode of cure the better;
d medicated dressings that
than were the charms and
s required for most wounds
thin gutta percha to keep
requires. Plain water is
e cases.

e, are accidents frequently
done by improper manage-
treatment must be adopted
se caused by intense cold,
ust be brought about gra-
; in the other, cold appli-
n being produced but very

slowly. If a frostbitten part is suddenly brought near the fire it will almost certainly be destroyed; whereas if the circulation is gradually restored by rubbing first with snow or cold water, and increasing the temperature by degrees, it may be saved.

Wounds received from venemous animals, especially snakes, produce their injurious effects so rapidly, that no time should be lost in treating them. To prevent the absorption of the poison a bandage should be tied tightly round the limb above the bitten part, so as to obstruct the return of blood to the heart, and the wound may be cut out, or burnt with a hot iron, while the great constitutional depression that usually follows should be combated by the free and early administration of the most powerful stimulants, as ammonia, brandy, &c. It would be highly interesting and often useful to travellers if they were to learn what venomous animals existed in the country they were about to visit, and how they might be distinguished from the harmless species.

The treatment of persons apparently drowned, though not strictly surgical, is a subject of great interest, far too extensive, however, to be entered into, upon the present occasion.

It is not within the scope of this lecture, nor would it be possible in many lectures, to *teach* even the elements of surgery. I can only indicate the above as subjects which appear worthy of particular attention. A practical knowledge of them is the only one of real value. The sight of a few such injuries properly treated would be the best means of gaining this. Any one about to travel into remote regions, could not do better than attend for a few months at the out-patient department of a large hospital, where all the minor accidents are daily treated in such numbers as to afford in a short time specimens of every variety. Of course such an undertaking would not be necessary to officers in the ordinary circumstances of the service, who are now seldom far from the assistance of well-educated surgeons; but even with them a little reading and thought bestowed upon the subject, and a little conversation with, and instruction from, their own medical officer, may be the means of affording in some unexpected moment valuable aid to a suffering fellow-creature.

Wednesday, March 23d, 1859.

The Right Hon. the EARL OF ELLENBOROUGH, G.C.B., in the Chair.

ON THE FINANCIAL AND EXECUTIVE ADMINISTRATION OF THE BRITISH INDIAN EMPIRE.*

By Lieut.-Col. J. P. KENNEDY,

Formerly an Officer of the Royal Engineers, Military Secretary to the late General Sir C. Napier when Commander in Chief in India, and Consulting Engineer to the Supreme Government in India for the Railway Department.

1. MORE than a year has elapsed since I had the honour of addressing the members of this Institution on the subject now under review.

That period has brought forth events as creditable to the character of the British Empire as they promise to be promotive of its broadest interests.

2. We have witnessed the transfer of British rule in India to the direct and responsible authority of a single Minister of Her Majesty's Government; and the intelligible exposition just offered to Parliament, by this first responsible Minister for India, *is a hopeful earnest of prospective benefit from the change so long and earnestly invoked.*

3. We find that social order has succeeded to the anarchy which for a time existed in India, and that, in the process of this change, not only has *a ferocious army of mutineers been overthrown*, but a host of bilious lecturers upon "human deterioration," and "the wane of British power," been practically answered.

4. It has been proved that a culminating point of moral and physical excellence characterizes the British people of the present day; *for the annals of the world do not offer another ordeal so searching* as that by which our countrymen have been triumphantly tested in their long Indian struggle.

A struggle not confined to our glorious soldiers and their prescient and gallant leaders, but unflinchingly sustained by all our race there, *without restriction* to profession, sex, or age! Assuredly, so long as a nation is peopled by such a race *it must be invincible* and progressive! A faithful record of British resistance to the Indian mutineers will offer the brightest page in history, as proving the most *indomitable perseverance, courage, and*

* In consequence of the very great importance of this Paper at the present juncture, and the high interest taken in all matters connected with the future peace and security of the Indian Empire, and the organization of the Indian Army, the Council have considered it expedient to print Colonel Kennedy's Lecture out of its regular course, in order that it may be sooner brought before the public.

fortitude of which the human race has shown itself capable under such unexampled and protracted difficulties; whilst, on the other side, in analysing the producing causes of the events, it must exhibit the most dismal picture of those disasters which nations undergo from an irresponsible and improvident administration of public affairs.

Finance.

5. The object of my former address was to stimulate the application of a remedy for the past omission to furnish the Indian territories, at the fitting times, with the first essentials of civilization,—*the means of intercourse and transport.* I sought to prove that this grave omission was *ruinous to the public finances,* obstructive to industry, trade, and commerce; impedimental to the administration of justice, education, police, as to all other civil objects of State superintendence; and, finally, HAZARDOUS to the English inhabitants, to our military reputation, and to British power, by the difficulties that were thus left opposed to the concentration of the limited number of European troops so thinly scattered throughout that enormous and populous Empire.

6. These propositions were broadly stated in principle, so far as relates to the financial question, by Her Majesty's Secretary of State for India in his lucid exposition made to the House of Commons on the 14th of last February (1859).

He shows the revenue of India to be about £32,000,000, under four principal heads, viz.:—

1. Land Rent, about £19,000,000, or 60 per cent. of the whole.
2. Opium . 6,000,000, „ 20 „
3. Salt and Customs 4,300,000.
4. Miscellaneous 3,000,000.

He shows that the expenditure of the two years 1857–8 and 1858–9 left an actual deficit of £21,600,000, wholly attributable to the Insurrection.

He gives the military expenditure of 1856–7, as an average year prior to the Mutiny, at . . . £11,546,000
Do. 1857–8, first year of Mutiny . 18,212,000
Do. 1858–9, second do. . . 22,598,000*

Finally, he shows for the last two years an average annual revenue deficiency of about £9,000,000.

7. In speaking of the Land Rent, which he describes as contributing 60 per cent. of the entire revenue, he says, "and we must therefore consider this branch of the revenue *as being comparatively inelastic. The increase* of which it is capable arises principally from two causes. One cause of increase, which has been very active in times past, but of which we may hope there will be no more just at present, is addition to the British territory, and consequent increase of the area over which the tax is levied. *The other cause is the taking into cultivation of lands hitherto*

* The rupee is calculated here at 2*s*.

increase, as Railways, and
erior of the country; and
ource of GREAT WEALTH at

d from Opium, one-fifth of
ssigned, as fluctuating and

x.

of revenue and expenditure

ution of Indian revenue, nor
problem of Indian finance is
military expenditure within

y one portion of the entire
tion is complete, with the
obvious that the distance
a position to be brought
rapidly than before. So
communication, to which I
commenced, will in a short
he troops there will then be
y."

of the Secretary of State for
ncreasing the revenue of that
the means by which waste
e manner that his *hope of*
nution of the military estab-
nable, by bringing together
ill then be efficient in many

inance within the following
revenue must be provided
way shall have been con-
litary force.

itution a year since, *in the*

n the same view, we may
struction will now be made
erto been the rule.
on in tending to bring the
measured as follows:
and the ratio of British to
, prior to 14th Feb. 1859,
ted to the existing circum-

	Total Troops.
	335,546.

fects in the Police Force shall
Government can reduce 346

British and 1616 *Native troops for every* 100 *additional miles of railway which shall be opened for traffic, until the army shall have been brought down to a permanent establishment of* 50,000 *British and* 50,000 *Native troops*, keeping the Artillery, Engineers, and Sappers, all British.

14. We are now in the Spring of 1859, and the process MAY be completed as follows, taking the present cost of the army to be £14,000,000, and its strength 91,590 Europeans, and 243,956 Natives.

	Miles of Railway opened.	Troops Reduced.		Troops Remaining.		Army Cost.	
		British.	Native.	British.	Native.	Reduced.	Remaining.
1860	2,000	6,920	32,320	84,670	211,636	1,210,601	12,789,399
1861	4,000	6,920	32,320	77,750	179,316	1,210,601	11,578,798
1862	6,000	6,920	32,320	70,830	146,996	1,210,601	10,368,197
1863	8,000	6,920	32,320	63,910	114,676	1,210,601	9,157,596
1864	10,000	6,920	32,320	56,990	82,356	1,210,601	7,946,995
1865	12,000	6,920	32,320	50,070	50,036	1,210,601	6,736,394
		41,520	193,920			7,263,606	
		235,440		100,106		£14,000,000	
		335,546 men					

If this course can be pursued, in six years the army expenditure may be reduced progressively till it reaches a gross reduction at the end of that time over £7,000,000, leaving the permanent cost something below that annual amount.

15. If it be argued that 2,000 miles of railway per annum are more than can be opened in India, the simple answer is, that a much more rapid rate of progress was accomplished in America, with *iron materials principally, and capital to a considerable extent supplied from England*, and without any approach to the urgent need that should now stimulate our progress in India. *What Americans* HAVE DONE, *Englishmen* CAN DO! The railway mileage opened in America was, in 1848, 932 *miles*; in 1849, 1258 *miles;* in 1850, 1506 *miles;* in 1851, 2022 *miles;* in 1852, 2437 *miles;* in 1853, 2196 *miles;* in 1854, 3927 *miles;* in 1855, 2009 *miles;* in 1856, 2841 *miles!* In those nine years the aggregate value of iron carried from England to the United States was £27,155,152—from England to the East Indies *only* £3,840,230. In 1857 it was ascertained that an aggregate of 26,000 miles of railway had been opened in America from the commencement in 1830! whilst up to 1857 only 358 miles had been opened in India; and the mileage open there at the present time is but 559 miles.

16. In my former address to this Institution I stated, "that the construction of a sufficient portion of well selected lines of railway, say 12,000 miles, at a cost of £72,000,000 (which may be accomplished in six years), will admit of a reduction in the numerical strength of the Indian armies of occupation from 325,000 men to 100,000, with a cor-

rom over £18,000,000 to
nual revenue deficiency of
2nd. They will likewise
to any given point of any
00,000 men, *costing only*
E required to concentrate,
stributed army of 325,050

, that the excess of expen-
the military establishment
exceeded what I had anti-
ble urged as a remedy, and
T REMEDY, *becomes the more*

ered is that of Irrigation;
r intercourse, is undoubt-
improvement and finance.
additional produce which it
e unless the requisite means
in existence, *by which it can*
good in reference to every
empire can be made to yield.
he enormous profits which
igation.

ency, opened in 1836-7, at
verage net yearly profit for
cent. per annum. That of
ned in 1852-3, at a cost of
ased revenue of £44,000,

t £2,700, and paid £5,000,
er paid 58 per cent. of its
£3,600, produced £5,000,
; yet with all these palpa-
ion investments, *effected by*
e made to relieve the em-
nd that a portion of this
00, has been assigned to a
guarantee of 5 per cent.
!

nment themselves at only
s palpably below the real
ving assumed the *entire risk*
the prospect of enormous
ing £400,000 a-year, with
provided for !!!

iment, yet it was precisely

what has been done to the extent of about £30,000,000 of capital in the railway investments! *The true principle of finance is, where a party assumes all the* RISK, *that he should likewise appropriate the profits, and make his arrangements accordingly for executing the undertaking through his own agency.* The Government have much greater facilities for making good arrangements in those matters than private companies.

21. The boards of direction of companies, however fitted for deliberative investigation, are necessarily the most unsuccessful class of administrators that has yet been placed to direct any executive operation. This fact has been proved, *even to a proverb*, in English joint stock companies.

22. Irrigation in India is a fitting subject for Government investment on their own account, and to a large extent. If they think fit to invest £10,000,000 on that account, within a moderate period and on sound principles, they may fairly expect to realise 40 per cent. annually; which would enable them to wipe away the salt monopoly, justly defined by the Secretary of State as a poll tax. It is not only a poll tax, but a monopoly which shuts out from general commercial use one of the most important articles in nature.

23. It is true that the Indian Empire has been handed over to Her Majesty's Government in a most lamentable condition, with—

First. A native army of 100,000 men in revolt, and undergoing the process of annihilation;

Second. A disorganized police force of 600,000 men, whose practice, as described by the highest Government authorities, is rather to outrage than protect the laws and the people;

Third. A most harassing system for the administration of justice in the criminal and superior civil courts;

Fourth. A territory teeming with products, *which cannot be reached by commerce, capital, or industry*, owing to the absence of roads of intercourse;

Fifth. The remuneration of the labourer only 3*d.* per day;

Sixth. A public expenditure which must exceed the revenue, although happily in a decreasing ratio, for two or three years to come.

24. Here we have undoubtedly *a murky political horizon*, but there is one ray so bright shining through it as to give the statesman not only a hope, but certainty, that the gloom is but temporary, and must rapidly pass away.

25. Whatever may have been the results in other respects, it were an unfair omission to pass in silence one most important financial principle of the former Rulers which redounds to their honour as administrators of Indian affairs,—one for which both the British and the Indian people must acknowledge their lasting obligations,—one also which the practice of England and nearly every other country would have justified them in withholding—

They did not alienate from the state its public property!!

They did not give to private individuals the fee of the land, which now yields a legitimate revenue amounting to nearly four-fifths of the entire state income, including that class of produce, opium, which they reserved the exclusive right to cultivate.

26. Had the fee of the land been handed over in large estates to feudal proprietors in India, it would have been sub-let to occupiers at probably

e state. The rent would
the produce, and an equal
axes upon the industry of
e. Every sound political
the necessity of imposing
t pressing upon any occu-
which it would not have
it been given in large fee

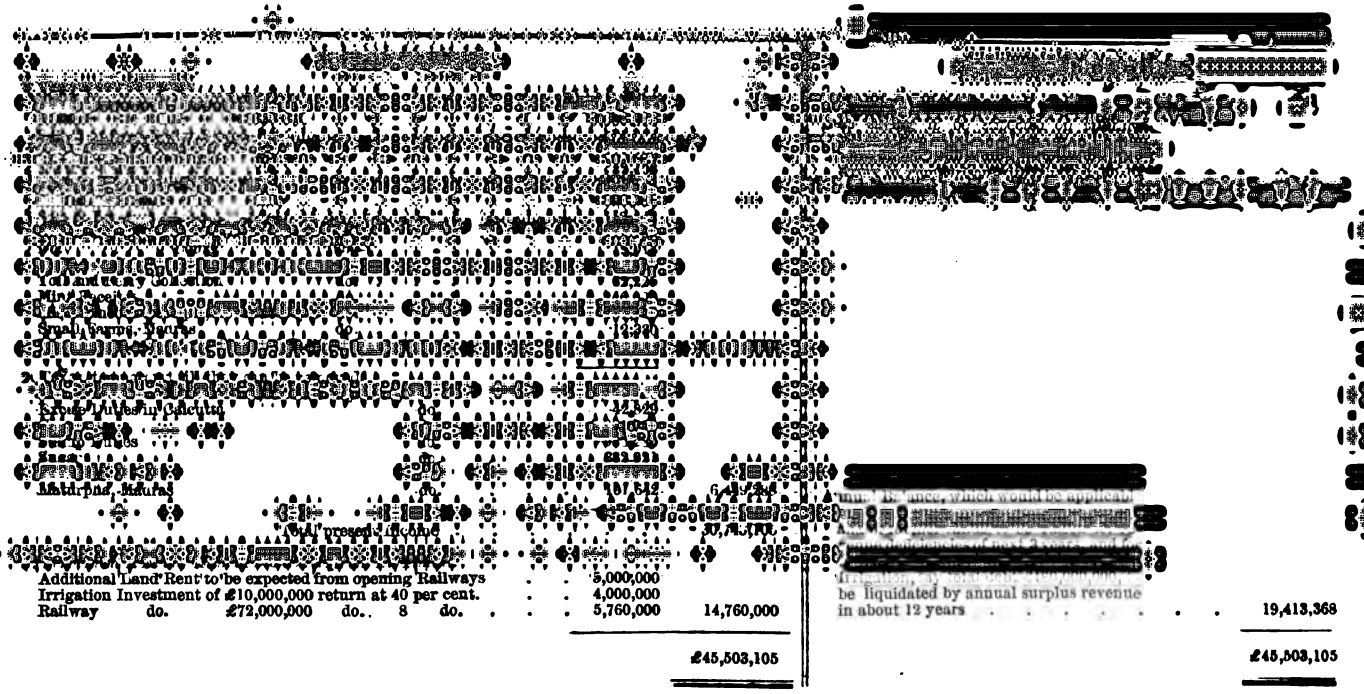
offers vast public benefits,
nal duties and responsi-
the functions of the most
ve and executive direction
the entire landed property
elopments of wealth and
first created by the accu-

uly Herculean. It has to
tion, not only the public
ial proceedings of its 130
ower *wisely directed* would
of conferring general bene-
There are no secondary
plied or their consequences
scarcely have divided its
, without producing even
ements are becoming daily
medies more general and

n place will give the best
ture. We may now look
urgently called for, that,
he most stringent adminis-
which there should be no
, to fulfil, because it has
, if judiciously conducted,

n this view of their position
aces of their empire would
e imaginings of the most

n account to have com-
railway construction from
account, at about £6,000
rn of 8 per cent.; to have
stment of £10,000,000 on
per cent.; finally, to have
vernment in borrowing the
ld have been able to offer



Additional Land Rent to be expected from opening Railways			5,000,000	
Irrigation Investment of £10,000,000 return at 40 per cent.			4,000,000	
Railway do.	£72,000,000	do. 8 do.	5,760,000	14,760,000
				£45,503,105

be liquidated by annual surplus revenue in about 12 years	19,413,368
	£45,503,105

Note.—In this Statement the Rupee is calculated at 1*s.* 10½*d.*

d the public income under

ined as a return for some- being a necessary of life ion. The Government in me private speculator or nself be willing to supply the Government assigned

ktorted by some ingenious Government in reference is made, but simply as a der other heads.

	£	£
. .		26,089,737
	24,293,817	
	14,760,000	
	6,449,288	
. .		19,413,368
	£45,503,105	£45,503,105

at might have been done if This financial policy how- ted will produce a large of revenue. It will enable e—the import and export direct. It will provide for cial and education depart- g public debt, but likewise ion of railways and of irri- ue exceeding £19,000,000 land rent, &c.

he indispensable improve- ated in a period of about ed to meet deficiencies of bject for the next two or reproductive investments; to have been removed; afterwards to the reduction vast benefit, in diminishing saries of life.

he British territories. The e must in fact regulate the where overcharges would

hoped for were the fee of dual inheritors. Not even on a par with our own bility and landed gentry.

Land must in such a case be dealt with as any other private property, and therefore be rented at its full market value. The revenue necessary for a state must be regulated to meet a certain indispensable expenditure, whilst the revenue looked for by individuals, *even when most conscientious*, has no such limitation.

34. The security for the fulfilment of this financial principle rests upon four assumptions, that few will venture to controvert, viz.:—

First. That a large proportion may be added to the productive surface of India by the extension of Railways and Irrigation Canals.

Second. That the revenue from Railways, if *executed* judiciously, on account of Government, should give a net return of 8 per cent. on their cost to the public revenue. British Railways give about 4 per cent. on a mileage expenditure, five fold more than is required in India *with the experience now available*, which would thus, on the more limited scale of expenditure, be 20 per cent. The American Railway revenues have reached 8 per cent. on their cost in an agricultural county having a population of only nine souls to the square mile, whilst India, with richer resources, has 124 souls per square mile.

Third. That the returns upon judicious irrigation investments should average 40 per cent. It is to be recollected that works of this class cost less comparatively than any others, whilst their reproductive effect must be the greatest; and those who have considered the subject will not be surprised at the enormous profits realised in practice by the Government of India in the cases which they have dealt with. But, with such experience, all must be surprised that it should not have been undertaken on a scale commensurate with its importance, and solely upon Government account. Such a scale would secure for the fertilization of the land, within a certain ratio of expenditure, all the water that is now wastefully permitted to flow into the ocean in the dry seasons of the year.

Fourth. A most advantageous principle would be,—that the British Government should so far enlarge their policy in dealing with their Indian Empire as to join in the security on which the required loans may be obtained to bring about the rapid industrial and financial development here contemplated in that country. The question is whether for a mere point of etiquette they will put themselves (for I treat British interests as identical with the interests of India) to an unnecessary cost of about £5,000,000 a-year, for some years to come, by forcing upon India the necessity of borrowing, at 5 or 6 per cent., what might, under a British guarantee, be obtained at 3½ per cent.

35. India is the only Foreign British Possession which yields to this country large and direct profit, whilst every other colony causes considerable direct outlay. It would not only be *equitable but possible* to have a return for the accommodation here suggested by placing a fair proportion of the British fleet on the Indian establishment, as the Army in the East already is; assuming that the Indian finances were on the wholesome footing of which they are susceptible.

36. No reasonable statesman could object to such a portion of the general expenditure of the United Kingdom being borne by the respective colonies as their circumstances, taking them as integral portions of the Empire at large, might warrant, and recollecting that they all enjoy the

t the exact ratio that it is
efficient naval and mili-
ther empires.
equitably calculated, could
strong practical objection:
paid; and the exception
policy of having in that
State, or fee of the land,
iduals! Had the rest of the
ional example, its rulers
cent that ever governed a

which at present excites
settlement of Europeans
country. It is earnestly
his view may be strictly
also within the sound
is branch of the adminis-

nt.
h shall not be as equally
soil.
nd followed up to its full
responsible duties insepa-
very few years must place
adition, and must exhibit
ne annals of any Govern-
er without a single tax,

UDENCE.

l principle of finance in
of the leading subjects of
t country.
f that the military depart-
s undeniable fact that the
efficiency of our Indian
organisation being estab-
able the latter to enforce a
e the troops entirely from

nt may be, there must be
ordinary control of the
force. The organisation
ld be on totally different
to be employed in small
nd law. The military to
n agent of internal govern-
been seriously invaded by

some anarchical tendency in the people, and when moral restraint, backed by the minor police force, has been overcome or seriously threatened.

42. The ablest commanders and authorities on military matters have at all times resisted the employment of troops in those ordinary duties that ought to be executed by a well organised police.

This subject has been a source of much *bitter discussion and irritation*, from time immemorial, between the civil and military authorities in our Indian empire; of *innumerable ruptures and misunderstandings* where the public interests require *the most cordial sympathy and co-operation to exist.*

43. The records of the Irish Government administration would exhibit similar effects from similar causes. So long as deranging influences and defective police in that country forced upon our army the duties of a constabulary, so long were the people rebellious, *the regiments employed there ill-disciplined*, and the *military commanders dissatisfied and remonstrant.* As soon as the police organisation introduced under Colonel M'Greggor had time to produce its effects *the evils vanished*, and the principle is as applicable to India as it was to Ireland, but more important would be its application in the ratio of the respective populations whose interest would be thus affected.

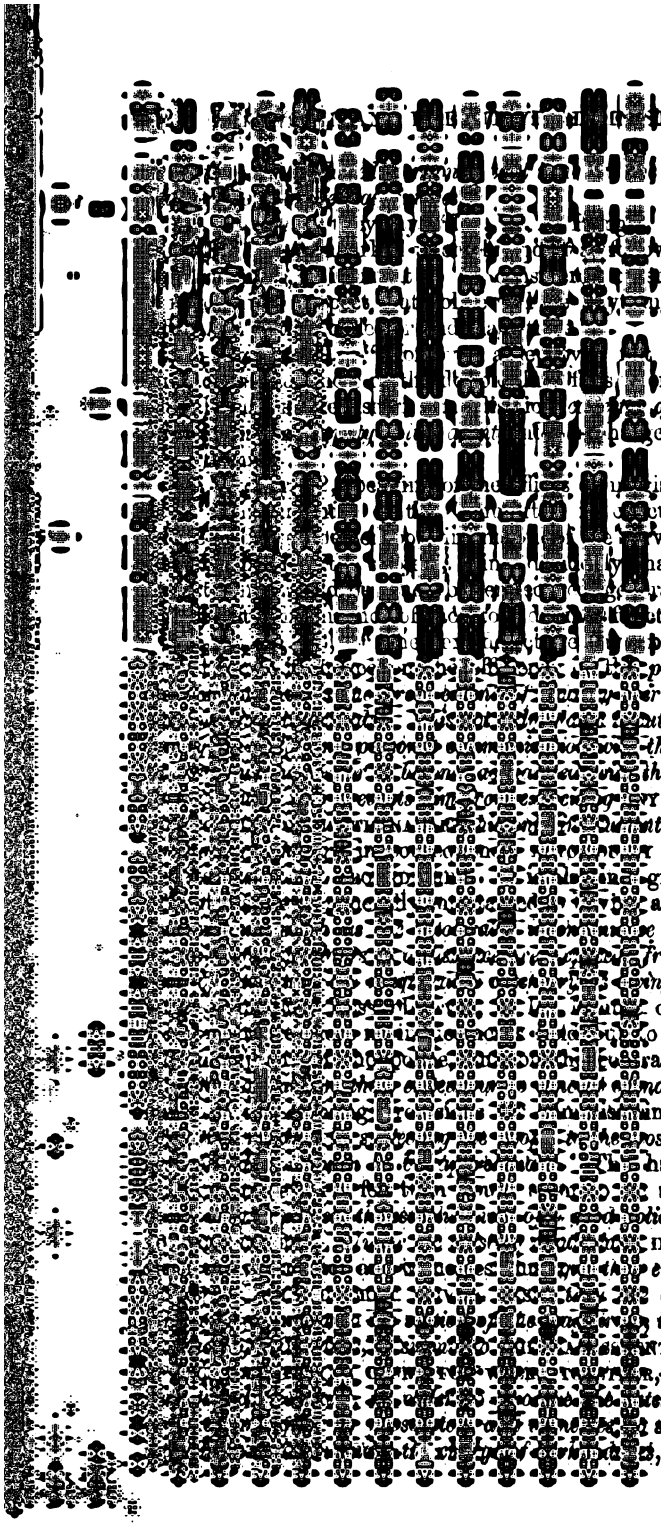
44. It is necessary here to give some idea of the police department throughout India, and *in doing so we shall scrupulously avoid* the description of men opposed to or desirous of criticising the administration of public affairs, and quote only the best informed and highest authorities in the Government itself from time to time.

45. The earliest record to which it is requisite to refer on this subject is the Report of the Committee formed by Lord Auckland when Governor-General, in 1838, to investigate the state of the Bengal Police. The present Lieutenant-Governor of Bengal was a member of that Committee.

46. At Par. 4, speaking of the improvements urgently required in the police, the Committee state, "*That urgency is admitted on all hands;* but it arises more *from the unpopularity of our system*, AND THE GRIEVOUS OPPRESSIONS CONNECTED WITH ITS OPERATION, than from any increased disposition to crime on the part of the community at large," &c.

47. At Par. 5, the Committee say, "The defects in question pervade every grade of the (police) establishment. . . . The magistrates are overwhelmed. The daroghas and their subordinate officers are corrupt; the village watchmen are poor, degraded, and often worse than useless; and the *community at large, oppressed and inconvenienced* in various ways, are not only disinclined to afford aid to the police, but in most cases *had rather submit* QUIETLY TO BE ROBBED than apply to the police officers for assistance to *apprehend the thieves*, or *to recover the stolen property.*"

48. At Par. 8,—"To the union of the office of *magistrate and collector* injurious effects are generally attributed. The union which formerly subsisted between the offices of *judge and magistrate* was not as prejudicial, because POLICE *was the primary* object of the judge and magistrate, *but it has been* SECONDARY WITH THE MAGISTRATE AND COLLECTOR. Civil business, it has been observed, can wait; but the Government cannot wait for its revenue. In *neither* case, however, is such a union desirable. If there be more business upon the whole than one man can perform, *a part must be neglected; and it has happened in both instances*, and must be invariably the



THEM UNDER RESTRAINT, AND SOMETIMES IN CONFINEMENT, *on the pretext of accommodating them with lodgings.*"

VILLAGE POLICE.

53. At Par. 45, the Committee observes: "We now come to the most important subject connected with the police of Bengal, namely, the state of the chowkedaree establishment. *In some districts their numerical strength appears to be very great, yet they are utterly inefficient, and have been described in the most unfavourble terms.*" Mr. W. T. Hawthorn, Judge of Zillah Cuttuck, in his letter already referred to, observes, "*That from the total absence of any supervision over the village police* for a series of years, it may be said that at present such a body does not exist. The race of people denominated chowkeedars *retain the name apparently to blind the people as to their real character.* They are employed during the day to assist the zemindar in collecting his rents, *and at night they act as the agents* of notorious characters *to point out* where property is to be found. They seldom realize by honest means above one or two rupees per mensem at the utmost, and are therefore always ready to connive at offences on the promise of getting a share of the stolen property. It is not an uncommon trick amongst the chowkeedars to apply for leave of absence before a burglary or dacoity takes place to quiet suspicion against them, after having informed where property is to be found, and the time and manner in which the theft can be accomplished with the least chance of detection to the parties concerned."*

54. At Par. 46.—Mr. Hawkins, in his letter dated 11th January, 1837, says, "*Many a magistrate must have observed that a man has turned chowkeedar merely because it gives him an excuse for leaving his home at night, in order that he may go upon his thieving expeditions.*"

55. In a Minute by Sir George Clerk, when Governor of Bombay, on the subject of police in that presidency, and dated 28th April, 1848, we find the following:—

At Par. 1.—"It seems to me that the police throughout this presidency is on a footing in several respects most unsatisfactory."

At Par. 4.—"Here we have signal proofs of the influence of our present system of police, &c."

At Par. 5.—"Thus the insecurity of the high roads throughout the greater part of this presidency has become lamentable."

At Par. 9 to 15 is given the numerical force of police in the Bombay Presidency, amounting to 71,989 individuals, and costing £244,269, exclusive of some irregular corps then employed on police duties.

This Minute makes some very important suggestions for the correction of abuses.

56. The present Lieut.-Governor of Bengal, in his Minute of 30th April, 1856, states at Par. 3, in reference to the Tanna Police, numbering about 9,000, placed at 484 stations, in a territory of 150,000 square

* In Lower Bengal alone this branch of the *police* numbers 164,877. See Despatch from Government, 14th May, 1857, page 54. This gives over one of these police bandits to the square mile, as they are pretty equally distributed.

miles, having a population of 35,000,000. "For what after all has been done to improve the police during the last thirty years? We have ceased, it is true, to expect integrity from daroghas, with inadequate salaries and large powers, surrounded by temptation and placed beyond the reach of practical control; and we have somewhat curtailed the excessive and unmanageable extent of our magistrates' jurisdiction by the gradual establishment of thirty-three subdivision magistrates."

57. At Par. 10, referring to the village police, of whom there are 164,877 in his districts of 150,000 square miles, he states, "Village watchmen are now declared to have no legal right to remuneration for service, and (the help of the magistrate being withdrawn) they have no power to enforce their rights, even if they had any right to enforce. *Hence they are all thieves or robbers, or leagued with thieves and robbers, inasmuch that when any one is robbed in a village it is most probable that the first person suspected will be the village watchman!*"

58. And at Par. 13, in referring to the general statistics of three given years, he shows that 1130 of the village police were convicted of crimes, when, according to the ratio of their numbers, as compared with the crimes committed by the entire population of the same districts, the number for the police would have been but 321, or little over one-fourth of what they were; whilst of the 1130 crimes committed by the police, 19 were murder and Thuggee; 39 burglaries; 357 robbery and theft,—that is to say, "nearly one-fourth more in proportion to their number for these heinous crimes than were convicted in all the lower provinces of Bengal for all offences of every kind."

59. On the 24th September, 1856, the Court of Directors addressed a Despatch to their Governor General in India from which the following are extracts :—

Par. 1. "Our attention has been directed, on various occasions of late, to the character and proceedings of the police in different parts of India, and the reports, which from time to time have been laid before us, have combined, with many incidental notices of failure or abuse, *to deepen the conviction, that an immediate and thorough reform of police* IN ALL THE OLD PROVINCES OF BRITISH INDIA IS LOUDLY CALLED FOR. Par. 7. "*That the police in India has lamentably failed in accomplishing the ends for which it was established is a notorious fact;* THAT IT IS ALL BUT USELESS FOR THE PREVENTION, AND SADLY DEFICIENT FOR THE DETECTION, OF CRIME IS GENERALLY ADMITTED. UNABLE TO CHECK CRIME, IT IS, WITH RARE EXCEPTIONS, UNSCRUPULOUS AS TO ITS MODE OF WIELDING THE AUTHORITY WITH WHICH IT IS ARMED FOR THE FUNCTIONS WHICH IT FAILS TO FULFIL, *and has a general character for corruption and* OPPRESSION. *There is, moreover, a want of general organisation; the force attached to each division is too much localised and isolated, and the notion of combination between any separate parts of it,* with the view of accomplishing the great objects of a body of police, is seldom entertained."

60. The most important documents connected with this subject, because they deal with remedies for the defects they expose, are those accompanying a Minute by the present Governor General, dated 14 May, 1857, relating to the system of police in the Bengal Presidency; and amongst these the very admirable Minutes by the Honourable J. P. Grant,

Member of Council of the Supreme Government in India, are of inestimable value.

The following are extracts from his Minutes of 23rd November, 1854:—

61. At Par. 11, Mr. Grant says, "I do not think that those general and obvious objections to the union of *fiscal, police,* and *judicial powers, in the same* hands, which are admitted to have weight, and which rule the practice in all the well-governed countries of the West, are inapplicable in any part of India. At this moment, in the Madras provinces, an inquiry is on foot into the truth of a charge that has been made formally in Parliament, to the effect that, in those provinces where magisterial and fiscal power are in the same hand, the Government revenue is systematically raised by the use of torture inflicted by the native officers vested with these double powers."

62. At Par. 20,—"According to my ideas, it ought to be our *fixed intention,* as soon as possible, to dissever wholly the *functions* of *criminal judge from* those of *thief-catcher* and *public prosecutor,* now combined in the office of magistrate. That seems to me to be *indispensable as a step towards* ANY *great* improvement in our criminal jurisprudence; and ANY change of system to be made meanwhile, *should be* contrived, I think, with *regard to this fundamental reform.*"

63. At Par. 27,—"In one way only has any progress been made towards supplying the one grand want of the Bengal system, namely, in the establishment here and there, in excessively large districts, of a small number of *subdivisions,* presided over by an assistant to the magistrate or a deputy magistrate. *I would work out this one sound improvement to the utmost.*"

64. At Par. 28,—"Every district is already divided into several moonsiffships. I would give every moonsiff criminal judicial powers to a certain extent."

65. Par. 29,—"Every district is already divided also into *thannas, but these thannas are often very large. I think* no thanna station should be more than ten or twelve miles from its neighbour on any side."

66. At Par. 30,—"*Every district should be wholly cut up into subdivisions. Over every subdivision there should be either an assistant or an officer such as is now called a deputy magistrate,* to superintend the thannadars, and to control the police of the subdivision,* BUT WITHOUT ANY JUDICIAL POWER WHATEVER. These appointments should be reserved for the future as rewards for the best conducted of the thannadars. If we make this service as hopeful as the native judicial service, why should we not have as good native deputy magistrates as we now have principal sudder ameens, and as good thannadars as we now have moonsiffs? If we do not make service hopeful, what right have we to expect it to be good?"

67. At Par. 31,—"Sudder ameens are now located at the sudder stations, exactly where respectable officers of their sort are least wanted. I would increase their number and place one in each subdivision, with jurisdiction over the whole subdivision, and with criminal judicial powers to a certain extent,—say up to one year."

68. At Par. 32,—"At the sudder station, at his head quarters, I would

* This literally means a *police sub-inspector,* who ought not to be termed a *magistrate.*

d of all criminal judicial
of looking after the sub-
dinate policemen, of dis-
ses to conviction. At the
sudder ameers, assistants,
judges (by collectors also
ors have time enough to
be tried by moonsiffs and

d with the Mofussil will
ngs such as it would be
at with the existing state
for stealing an egg or for
at coming in perhaps 70 *or*
station, I think he would
. My system of criminal
nt be introduced in three
all expense. The existing
moderate language, is not
tional beings."

Honourable J. P. Grant's

ion as to the necessity of
f criminal justice, so far as
decisive effect the torture
sally."

system and invidious and
union in European hands

of the police force, as put
and brought prominently
by the revelations of the
he late Court of Directors
he question was, what that
l went deeper than a mere
red the administration of
functions in the same indi-
ding the office of chief of
tax collector, police officer,
endations urge, most vehe-
ng those functions wherever
t under a separate control,

ove in his practice, that a
ithout difficulty be applied

ice, not a magistrate.

to India. His earliest efforts in the administration of Scinde were successfully devoted to effect that vital improvement, and his example has been more or less adopted on the subsequent acquisitions of territory.

In a communication addressed by him in 1846, when Governor of Scinde, to the President of the Board of Control, we find the following: "To secure the peace of the country, and avoid disseminating the troops, which would render them familiar with the people, and possibly diminish the wholesome fear of our power, I established a police of 2400 men, well armed, drilled, and divided into three classes,—one for the towns, two for the country,—the first all infantry, the two last infantry and cavalry, called the Rural Police. They assist the collectors, *but form a distinct body* under their own officers.

Again, "Meanwhile, I have to say, the large force in Scinde has not been *for* Scinde, but for the Punjaub. I have for two years constantly said, that 5,000 men are sufficient and more than sufficient for the defence of, and for the maintenance of tranquillity in, Scinde."

73. Sir Charles Napier knew that an undisciplined, underpaid, or ill-controlled police are most insufferable oppressors, instead of what they ought to be under a proper organisation, the most efficient protectors of the people; and that upon their conduct, as representatives of the Government, *ramified into every hamlet*, they must be most active promoters either of loyalty or disaffection towards their Sovereign. Hence a perfectly sound principle of police he aimed at as the most critical and important of all Government departments. He would never consent to corrupt or deteriorate his troops by imposing upon them police duties, because he knew it to be the most costly as well as the most impolitic course he could adopt, whether as regarding the interests of the people, the government, the police, or the army. Thus, in proportion to the sound discipline and correct principle of action with which he could inspire his police, he was enabled to propose reductions in the numerical strength of his troops, as regarded the requirements of internal government.

74. It is an undoubted axiom, that if the laws affecting a country be proximately equitable in principle, and that the agency by which they are executed be vigorously controlled, so as to prevent and detect the abuse of executive power, the result will be a loyal and contented population, with light burdens; whilst the most perfect laws, executed by a corrupt or ill-controlled subordinate agency, must produce popular discontent, large military establishments, and heavy Government expenditure.

75. The first essential principle, therefore, *far before railways* or *any other object*, whether as regards the interests and loyalty of the people, or the future efficiency and limitation of the military force, should be at once to convert both the thannah and village police force of India, which may be estimated at about 600,000, and have been described by the high authorities above quoted as a scourge upon the inhabitants,—to convert these brigands *into one thoroughly controlled and organised police force*, reduced to less than one-fourth of that gross number. The present crisis has brought about the opportunity and means to this end.

76. If the principle of organising our native auxiliary troops in irregular regiments be adopted, there would be a surplus number of well-trained

sub-inspectors of districts

e recommendations, there
nade by him in the future
iminal justice; the omis-
y every other judicial and

ory and population, and to
istrative European super-
at once find a difficulty
circuit courts and sessions
European functionaries.
nt of British supervision
ilst extending the judicial
out which it is palpably
nt suited to the require-

that a general territorial
made on a well-digested
ervision and requirements

l district division in India
subordinate, is that of col-
calculated to convey the
gather up taxes. Our own
g more generally the idea
mpared with the English
t the inequalities or unfit-
the respective administra-
en more striking than in

nable at home, are compa-
ublic business is effected
or municipal representa-
and enlightened people,

or useful measure must
tinct official Government
class of officers, whose acts
elings, if not unintelligible
rule.
rintendence on the part of
solid security for the due
h the British nation has

taken upon itself in India ; and it requires, as an essential preliminary, that the division of departmental districts and sub-districts should be based upon the most comprehensive and convenient system of which the circumstances will admit, instead of the anomalous, unconnected and impracticable principle which is their present character.

81. An analysis of the old provinces of British India shows the disproportion between the smallest, the medium, and the largest collectorates to be as follows: viz.

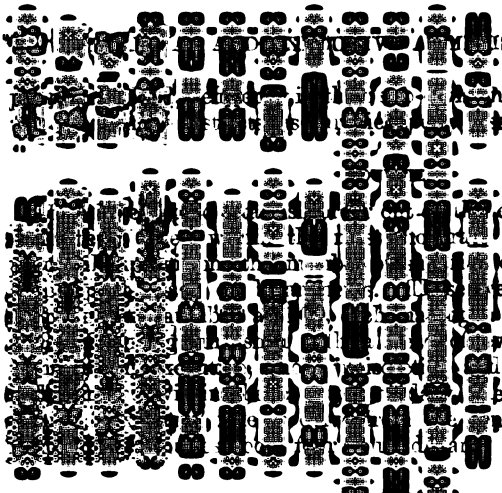
		Minimum.		Mean.		Maximum.
In Bengal	a ratio of	1	to	5	to	60
„ N. W. Provinces	do.	1	„	7	„	11
„ Madras	do.	1	„	2	„	4
„ Bombay	do.	1	„	6	„	20
„ Punjaub	do.	1	„	3	„	6

82. This would appear to be a fitting juncture to establish the whole of that subject on a footing that shall be free from the anomalies which we find operating at home as well as in India, where the territorial divisions appear to have grown up by chance. In England we find some counties manifold the size of others, both in area and population, although the general administrative arrangements in certain respects may be on an equal footing in each,—as Lincoln 2,776 square miles, and Rutland 150 square miles, or 18 to 1. These incongruities have forced in some egregious cases a division of the larger counties into sub-counties, as Yorkshire, Cork, &c. They are still so preposterous as to render necessary, with each successive legal enactment of certain classes, new and special divisions of the country suited to the particular requirements of each enactment.

83. These inequalities, however, in England are of comparatively slight importance, because every facility exists by which the inconvenience consequent to the larger districts is, to a great extent, neutralised. In India it is just the reverse. If a superintendence there be excessive, or beyond the reach of very reasonable exertion, as is generally the case, the functions of the office must be neglected, and the effect is most injurious to the interests of the people and the character of our Government. This tells upon districts of police, of magistrates, of justice, of education, of revenue, of public works, and of all other subjects, as it has told upon the military districts during the last conflicts. All departments are overstrained from the magnitude of the districts, the oppression of the climate, and the disproportion of the duties to the agency and means available for their execution.

84. A diagram will best explain how the judicial, police and all other districts having in view circuit courts and sessions, with departmental supervision and subordinate control, can be best formed to produce a general harmonious and mutually sustaining action throughout [*see Diagram*, p. 70]; how, in fact, Mahomet is to be taken to the mountain instead of continuing the effort to bring the mountain to Mahomet.

85. The British Indian territory of 837,412 square miles at present contains about 166 collectorates or departmental districts, answering, in their general objects, to English counties. Their defects are, first, great inequality in their comparative size and the duties they impose; second, deficiency in their combination into superior government districts or



ISTRATION OF THE

into inferior departmental
ions, police districts, &c.

elements now existing, it is
limits (that will admit of
districts requiring able and
e shall term counties, and
radius of about 45 miles,
very principal department,
control would be respect-
e most distant point being
tre, and the stations of the

rm one convenient sized
neral charge of a Govern-
Government provinces for
issioner being within about
he four counties under his

departmental district would
, or spaces 30 miles square,
hours' ride of the extreme

CTS.

um] might be either into nine
or four of 225 square miles
olice districts, &c. according
respectively shown on the
convenient, as bringing the
boundary; five would bring
des from the boundary; four
iles of the boundary. As
the constabulary force, the
four police districts would
olice stations, and, allowing
ves, the cost for the entire
millions per annum for 81
for 36 stations per county,
st from all sources of the
India taken together.

be conclusive as to the
r petty sessions and police
ave a right to complain, as,

To face p 70

Diagram to Illustrate a Division of Territorial Districts in India Suited for Civil, Criminal and Appeal Circuit Courts. Police organization and Control, Revenue Collection, General Government Supervision of all Departments, Military occupation of the Country And for the acquirement of Statistical Information

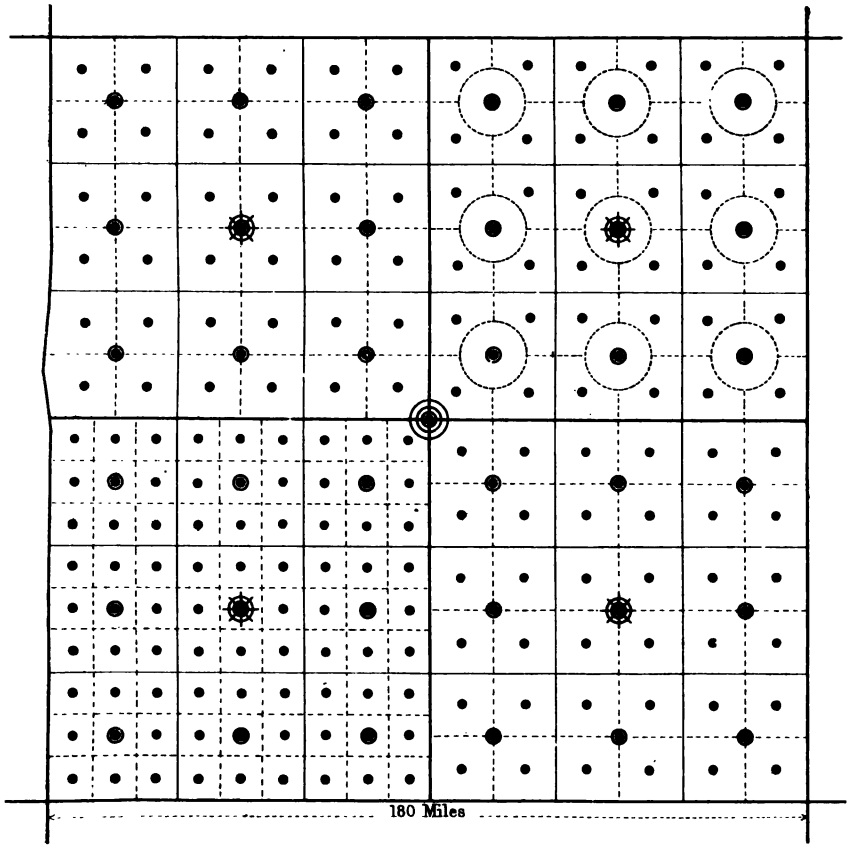


Diagram contains one Province of 32.400 Square Miles Average Population 5.000.000 British India 837.412 Square Miles would form 26 similar Provinces.

Centre of Province. Radius of Inscribed Circle 90 Miles. A Government Comm^rs District and a Military Brigade district contains 4 Counties.

Centre of County, Radius 45 Miles contains 9 Baronies. A Circuit for Superior Civil Criminal and Appeal Courts, to sit at Centre of each Barony.

Centre of Barony Radius 15 Miles, contains 9. 5 or 4 Petty Sessions Districts. A Circuit for Inferior Civil and Criminal Courts, to sit at Centres of Petty Sessions Districts

Centre of Petty Sessions Districts, Radius 5. 6 3/4 or 7 1/2 Miles, Petty Sessions District to contain 9 Elementary School Districts.

J.R.Jobbins.



regarding the administration of justice, it would bring the inferior circuit civil and criminal courts within 7½ miles of the most distant inhabitants of the land, and, as regarding the efficiency of the police and other executive departments, it would bring those in charge of such districts within 7½ miles of their boundary.

We shall, therefore, adopt for further detailed consideration the principle of dividing the barony into four sub-districts for police, petty sessions, and other administrative purposes.

Police Establishment and Organization.

90. The principal officer in charge of the entire police of the county might be called the county inspector. Of these there might be three classes, of which the salaries might be respectively 1,000, 800, and 600 rupees per month, giving one first-class inspector, one second-class, and two third-class inspectors to the four counties of each province; these might be in the first instance selected from field-officers or captains in the army.

Under the county inspector there should be nine sub-inspectors, one in charge of each barony. They should stand in three classes, of which the salaries might be respectively 500, 450, and 400 rupees per month, giving to each barony one sub-inspector of the first-class, one of the second, and seven of the third.

Under each barony sub-inspector there should be four chief constables, each in charge of the police party of twenty-five men in an elementary police district of 7½ miles radius, co-terminous with a petty session district. The chief constables should be natives, promoted by merit from the inferior grades, and being eligible, if deserving, of promotion to the higher ranks of sub-inspector and inspector. There might be three classes of chief constables: the salary of the first-class being 150 rupees per month, the second 100, and the third 80; and their proportion being one first-class, one second-class, and two third-class for the four stations of each barony.

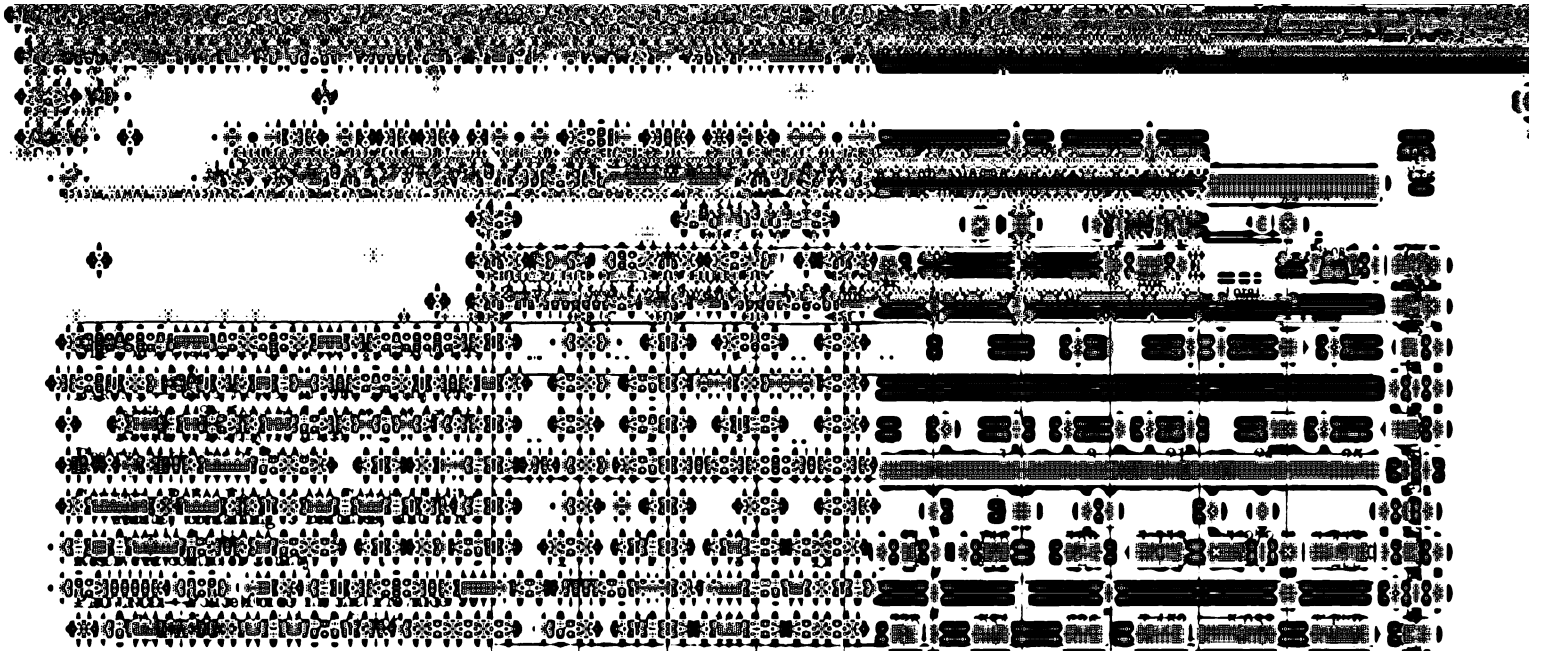
Under the chief constables there might be three classes of constables, receiving 16, 14, and 12 rupees per month, and three classes of sub-constables, receiving 9, 8, and 7 rupees per month respectively. There would be also a proportion of mounted constables and sub-constables, receiving 20 rupees additional to the pay of their rank and class per month. This classification would have an important effect, by keeping constantly before the men the fact of frequent promotion for meritorious conduct, with a perfectly understood principle that the highest position in the force would be open to the exertions of every man in its ranks. The following Tables give the details in a general view:

ng the ESTABLISHMENT

entary Station. rict 225 square miles lins. Men.	Barony, 900 square miles, contains 4 Stations and Reserve.		
	Distributed at 4 Stations.	Reserve at Centre.	Total in Barony.
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	1	1
.	. .	1	1
.	1	. .	1
.	1	. .	1
1	2	. .	2
1	4	. .	4
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
.	. .	. .	. .
1	4	1	5
1	4	1	5
1	4	1	5
1	4	1	5
3	12	3	15
1	4	1	5
1	4	1	5
19	76	19	95
21	84	21	105
24	96	24	120
25	100	25	125

proposed for POLICE FORCE of BRITISH INDIA.

County, 8,100 square miles, contains 9 Baronies.			Province, 32,400 square miles, contains 4 counties.	British India, 837,412 square miles, contains 26 Provinces.	Monthly Pay per Man in Rupees.	Yearly Cost of proposed Police in British India.	
Distributed in 9 Baronies.	Reserve at Centre.	Total in County.	Men.	Men.		Rupees.	£
. .	1	1	1	26	1,000	312,000	31,200
. .	. .	. .	1	26	800	249,600	24,960
. .	. .	. .	2	52	600	374,400	37,440
. .	1	1	4	104	. .	936,000	93,600
1	. .	1	4	104	500	624,000	62,400
1	. .	1	4	104	450	561,600	56,160
7	1	8	32	832	400	3,993,600	399,360
9	1	10	40	1,040	. .	5,179,200	517,920
9	. .	9	36	936	150	1,684,800	168,480
9	. .	9	36	936	100	1,123,200	112,320
18	3	21	84	2,184	80	2,096,640	209,664
36	3	39	156	4,056	. .	4,904,640	490,464
. .	4	4	16	416	36	179,712	17,971
. .	4	4	16	416	34	169,728	16,972
. .	4	4	16	416	32	159,744	15,974
. .	12	12	48	1,248	. .	509,184	50,917
. .	10	10	40	1,040	29	361,920	36,192
. .	10	10	40	1,040	28	349,440	34,944
. .	64	64	256	6,656	27	2,156,544	215,654
. .	84	84	336	8,736	. .	2,867,904	286,790
45	101	146	584	15,184	. .	14,396,928	1,439,691
45	8	53	212	5,512	16	1,178,304	117,830
45	8	53	212	5,512	14	926,016	92,601
45	8	53	212	5,512	12	793,728	79,372
135	24	159	636	16,536	. .	2,898,048	289,803
45	8	53	212	5,512	9	595,296	59,529
45	8	53	212	5,512	8	529,152	52,915
855	152	1,007	4,028	104,728	7	8,795,952	879,595
945	168	1,113	4,452	115,752	. .	9,920,400	992,039
1,080	192	1,272	5,088	132,288	. .	12,818,448	1,281,842
1,125	293	1,418	5,672	147,472	. .	. .	2,721,533



BRITISH INDIA.—Police Force in British India, area containing 26 Provinces . . .	104	1,040	4,056	1,248	8,736	15,184	16,536	115,752	132,288	147,472
WAR CONTINGENT.—Proportion of Police Force which might be temporarily detached in aid of military for objects of war, viz. Cavalry .	..	78	104	1,248	8,736	10,166	..	..	..	30,316
„ „ „ Infantry	..	78	104	..	..	..	2,496	17,472	20,150	
Monthly rates of pay in rupees { 1st class .	Rupees. 1,000	Rupees. 500	Rupees. 150	Rupees. 36	Rupees. 29	..	Rupees. 16	Rupees. 9		
2nd „ .	800	450	100	34	28	..	14	8		
3rd „ .	600	400	80	32	27	..	12	7		
COST.—Total yearly cost of proposed Police Force for British India	£ 93,600	£ 517,920	£ 490,464	£ 50,917	£ 286,790	£ 1,439,691	£ 289,803	£ 992,039	£ 1,281,842	£ 2,721,533

ADMINISTRATION OF THE

91. Such an organization would enable the sub-inspector of any barony to concentrate to the most distant point of his district, within six hours, 100 men.

It would enable the county inspector to concentrate rapidly 900 men to any one point of his district.

It would enable the Government commissioner of the province to concentrate rapidly 3,000 men on any point of his district.

It would enable the Government on any urgent emergency of war at once to reinforce the regular military reserve by a well-organized force of 10,000 police cavalry and 20,000 police infantry, and by recruiting to repeat such reinforcements to any extent required.

92. The gross cost of this police force, numbering 147,472 men, upon a liberal scale of pay, placing them beyond the *necessity of committing depredations for their livelihood*, would be 2,721,533*l.* per annum, or about the aggregate of what is now paid in different ways to the 600,000 depredators comprising the present village and thannah police. But from this estimated amount there would be the saving of the pay of the military officers—whose regiments having deserted them in the mutinies, leave them available for this most important organization. Thus we may calculate that the improved police and their officers, taken together, would produce a saving of about half a million annually, as compared with the former expenditure under these heads.

Civil and Criminal Jurisprudence.

93. Having corrected the most dangerous and oppressive system that exists in India, by disbanding the 600,000 village and thannah police, and organising a well-controlled and disciplined protective constabulary force of 147,472 men, the next subject in importance would be to improve the administration of justice, both civil and criminal—

First. By taking all judicial power out of the hands of revenue collectors and police officers.

Second. By establishing a moonsiff's barony circuit court in each barony, with both civil and criminal jurisdiction to a limited extent, for the trial of minor cases; such court to hold a session monthly at the centre of each of the four petty sessions districts in the respective baronies, and thus to decide all minor cases, both civil and criminal, within a maximum distance of 7½ miles of the suitors, &c. instead of forcing them, as at present, to travel long distances to sudder stations.

Third. By establishing a superior county circuit court for the trial of graver cases, both civil and criminal, and for hearing appeals from the minor or moonsiff's circuit courts. The superior county circuit court to hold quarterly sessions at the centre of each of the nine baronies; thus making the maximum distance for suitors, &c. to look for justice in the heaviest cases fifteen miles, instead of the present radius of the sudder district.

94. Taking the average annual number of persons apprehended on criminal charges in the provinces of Lower Bengal for ten years, ending 1852, at 91,261, as recorded at page 76 of Despatch from Government of India, dated 14th May, 1857, we may compare proximately the oppression

elief that would be afforded

criminals due to an average
e diagram, would be about
unty; and allowing the due
the prosecution and defence,
e two journeys between the
the places of trial, the com-
les travelled by the various

tre of each large or county

aronies, 7,531,000 miles.
rior circuit courts, which is
n our calculations, the miles
nal cases in one year would

would have been within the
re the saving of oppressive
t, amounting to only 1-28th
d in but one branch of the
oached 11,469,600 miles of
ds saving may be increased
ior civil court business, and
as other public departments,
8,800 miles travelled, which,
f the same size proposed for
unt of 3,578 millions of miles
subjects would be relieved
ions were established at con-
public functionaries should
districts instead of dragging
rict.

agram county contains 8,100
l to one-sixth of the entire
district or barony is about
h county.

ent territorial division, shall
justice can be duly adminis-

functionaries the degree of
departmental supervision, it
existing number and conse-
ctionaries, whereas, with the
of the existing expenditure

nd of an efficient executive
ions, must remain impossible
round their districts holding
d times. There is no other

means of meeting the physical impediments interposed by vast distances and areas as compared with the largest amount of competent Europeans that can practically be supplied.

Military Forces.

96. Assuming the four great essentials to security, justice, industry, and good government to have been accomplished—

First. By disbanding the 600,000 "unscrupulous" men denominated police in all the old provinces of British India, and by organising instead of them a well-controlled and disciplined constabulary of 147,472 men, closely superintended by their own officers, who shall have neither judicial, tax-gathering, nor other conflicting duties to divide their attention.

Second. By entirely separating the incompatible functions of joint collector, police officer, and criminal judge.

Third. By establishing a new division of districts and sub-districts with *circuit* courts, which shall bring the administration of justice into every man's immediate neighbourhood, instead of forcing all those engaged in the more important civil suits, and in every class of criminal case, whether as parties or witnesses, to travel to fixed sudder stations at the centres of large districts.

Fourth. By constructing a sufficient amount of railway intercourse to permit the full development of productive industry, and the rapid movement of troops towards any given point.

97. Assuming these indispensable preliminaries effected, and the incentives to popular discontent to have been thus removed, we can fairly consider the number, the composition, and the organization requisite for a military force suited to such altered circumstances.

98. The regimental organization, discipline, and drill of the British army are probably as perfect as it is possible to make them. But the minute distribution of the forces in times of peace renders it very difficult to maintain the aptness requisite in dealing with combined bodies of troops, their movement in masses, means of transport, commissariat supplies, and military stores.

99. The effective police force above suggested for India will render unnecessary in that country the minute fragmental distribution of the military, which may have been heretofore unavoidable; and the smallest corps which under the improved system need be detached, with a view to the most effectual military occupation of the country, we may consider as a brigade composed of one European and one Native regiment of infantry, one European and one Native squadron of cavalry, one nine-pounder field-battery of European artillery, and one company of European engineers: on the aggregate 2,500 men, one-half being Europeans. According to the territorial divisions already proposed, one brigade so composed would be stationed at the centre of each province or Government commissioner's district, having a radius of about ninety miles, and three such contiguous brigade districts might form a divisional command.

100. The entire territory of British India would thus be comprised in

h the Government provinces
viz.

anage-

.	8	brigade districts.
l .	7	do.
es .	3	do.
.	4	do.
.	4	do.
otal	26	brigade districts.

or the general occupation of
e district of each brigade of
four forced marches, which
uired to concentrate any two
dary, thus bringing together
: four brigades, comprising
concentrated from four con-
gular point.

a disposable reserve of say
uld be requisite to meet every
e total military force about
aturally be posted in strong
nts, on our principal line of
stricts, and the north-western,
rs; and our general position
, the important flank of this
with the supreme civil and
njaub, North-west provinces,
nbay as at present.

with the precautions required
pal localities of the past dis-
ect the requirements of an

aining, to every branch of the
military success in the field,
tal fitness.

ion of our British troops more
as regards the questions of

ar to it sanitary stations, with
et above the sea, and offering
alth and comfort of Europeans
idency the Neilgherries, 7,000
f the same range to Poonah

Vindhya and Aravulli ranges;
ub skirt the Himalayas from
rding ample selections as to
line.

rd, after a matured settlement

of the deplorable disturbances which lately existed, and which happily are now crushed, to a future state of things that will admit of a very large proportion of the European troops in India being enabled to preserve their health during the summer in cool stations, from whence in any emergencies the train (when established—and much hangs upon this) will rapidly convey them to any required points of action.

Composition of the Army.

104. The composition of the army has been hitherto about 1 European to 5½ natives. In future the proportion would probably be 1 to 1, or nearly so; artillery all Europeans; engineers, sappers, and pioneers all Europeans.

The whole of the privates of the engineer corps should be trained as overseers and foremen, in order that, instead of acting as individual labourers or mechanics, they may be able to direct the labours of large masses of men. Thus the establishment of 2,000 sappers would admit of the profitable and well-organised employment of half a million of labourers, whether in military or civil works of utility or emergency; and one of the greatest deficiencies in India is the proper application of industry, which this organisation would tend to improve.

The army of India might consist of—1st. British troops from home establishment; 2nd. British troops on permanent Indian establishment, in equal or nearly equal numbers; 3rdly. British colonial troops, not natives of India, commanded by British officers; 4thly. Native irregular troops, commanded by British officers,—the number of the latter class not materially to exceed the aggregate of the three former classes. Every British regiment and colonial regiment not Indian, or from a tropical climate, should have two companies of natives attached to it, to be for the time under the orders of its commanding officer,—such attached companies belonging to certain native regiments allocated for this special duty. All native troops, both cavalry and infantry, hereafter to be raised should be Irregulars, and their commanding officers should have restored to them their former powers.

105. A Table is here necessary to offer a general view of the strength and distribution of the forces, both military and police, under the contingencies both of peace and of war.

The protection and defence of a people necessarily embrace the consideration of these two classes of force as complements of each other, and under the various political circumstances to which States are liable.

Police.—Native Force under 1,144 European Officers, viz.—									
Reserves of 104 Counties, 293 men in each, Natives	. .	. .	. .	. .	10,504	19,968	. .	30,472	147,472
Reserves at centres of 936 Baronies, 25 men in each, ditto	. .	. .	. .	. .	. .	23,400	. .	23,400	
Force at 3,744 Police Stations, 25 men at each, ditto	. .	. .	. .	. .	. .	93,600	. .	93,600	
Total Police, Natives	. .	. .	. .	. .	10,504	136,968	. .	147,472	147,472
Total of Military and Police forces for British India	. .	246	9,840	2,050	33,304	204,618	246	249,812	249,812

WAR DISTRIBUTION.

Concentrated.

Military.—Ordinary Reserve force concentrated	Europeans	. .	90	3,600	750	2,560	12,000	90	18,910	37,660
	Natives	. .	. .	. .	. .	6,000	12,750	. .	18,750	
1st Reinforcement from Provincial Military Establishment	Europeans	. .	120	4,800	1,300	1,920	10,400	120	18,420	34,670
	Natives	. .	. .	. .	. .	5,200	11,050	. .	16,250	
2nd Reinforcement from Police Forces	Natives	. .	. .	. .	. .	10,504	19,968	. .	30,472	30,472
Total available for war	Europeans	. .	210	8,400	2,050	4,480	22,400	210	37,330	102,802
	Natives	. .	. .	. .	. .	21,704	43,768	. .	65,472	
Total ditto Europeans and Natives		. .	210	8,400	2,050	26,184	66,168	210	102,802	102,802

Distributed in 26 Provinces.

Military distributed for protection of 26 Provinces, one brigade to every two Provinces	Europeans	. .	36	1,440	. .	1,920	10,400	36	13,760	30,010
	Natives	. .	. .	. .	. .	5,200	11,050	. .	16,250	
Total Military distributed, European and Native		. .	36	1,440	. .	7,120	21,450	36	30,010	30,010

Police under European Officers.

Reserves of 104 Counties	Natives	. .	. .	. .	. .	. .	18,720	. .	18,720	117,000
Reserves of 936 Baronies, 25 men at each centre, ditto		. .	. .	. .	. .	. .	23,400	. .	23,400	
Force at 3,744 Police Stations, 20 men at each, ditto		. .	. .	. .	. .	. .	74,880	. .	74,880	
Total distributed Military and Police, European and Native		. .	36	1,440	. .	7,120	138,450	36	147,010	249,812
Total concentrated for War, ditto, ditto		. .	210	8,400	2,050	26,184	66,168	210	102,802	
Gross Total Military and Police, Europeans and Natives		. .	246	9,840	2,050	33,304	204,618	246	249,812	249,812

nutually sustaining forces of
nts proposed, amount on the
would be military, one-half
eld-batteries of artillery, or
maining 147,472 would be
10,504 would be mounted
3 as irregular infantry.
s follows:—

		Men.
gades . .		37,660
entres of . .		64,680
ch, one- y, armed s to fur-	Men.	
c. .	30,472	
h ditto .	23,400	
ith side- .	93,600	
		147,472
for pro- . .		212,152

ollows:

ar:—

ve .	37,660	
brigades military . .	34,670	
n County third ca- ntry .	30,472	
or war . .		102,802

ces:—

g in 26 . .	30,010	
own from reinforce . .	18,720	
establish- . .	23,400	
men each . .	74,880	
protection of . .		147,010
nd Police .		249,812

107. The power of reinforcing the army from the ranks of the police may be carried to any required extent, provided the police be recruited, as they ought to be, for general service. Such reinforcements would naturally be furnished from the county reserves, which would be filled up again as regards the infantry by drafts of selected men from the barony reserves and station parties. The police cavalry would be recruited from practised horsemen, and the recruiting for the army through the police, spread over every district of India, would be a much safer principle than that heretofore adopted in Bengal.

108. The county police reserves we have estimated at about 100 cavalry and 200 infantry for each county, and, as there would be four counties to each Government commissioner's province, this would give a total county reserve force to the entire province of about 400 cavalry and 800 infantry. We have suggested that the centre of the province, or head quarters of the Government commissioner, should be the station for the military brigade; and, as the best protected point in the province, it should likewise be the position for the principal treasury and gaol, placing these establishments and the barracks for European troops, if not the entire brigade, within an earthwork redoubt or citadel.

109. Under this consideration the best position for—say two-thirds of the county reserves of the province, would probably be secured by concentrating them at the central provincial station or angular point where the four counties meet. This would provide an ample force of police for the gaol and treasury-guards, treasure-escorts, &c. and it would give the requisite security of a large force of military to those departments when particular emergencies might demand the presence of the police reserves in other parts of the province.

110. In fixing the permanent numerical force and composition of an army intended to protect the British Indian population and territory, an important subject for consideration would be the relative and aggregate strength and composition of the military resources of native states not under British rule. We find, and with reason, that the military forces of neighbouring states in Europe regulate more than any internal necessity the amount of force that each must maintain—relative weakness provokes aggression. Our capacity to resist aggression is the precise measure of our protection against provocation.

It is the only peace-preservation principle of any value in the present state of the world. In this view we must not overlook the statement given in a Parliamentary Return of 15th April 1852, which describes the forces of native states in India as amounting to 12,962 artillery, 68,303 cavalry, and 317,653 infantry, making an aggregate of about 400,000 men, or four times the number which is here proposed for the British Indian territory, although those states possess little over one-third of our population and about three-fourths of our area. Hence, according to our scale, the aggregate military of native states, instead of being 400,000 men, should only be 37,000 in reference to comparative populations, or 75,000 in reference to comparative areas. And giving a margin of 33 per cent. beyond the largest amount that either basis would bring out, as the aggregate military establishment of native states, we may admit 100,000 men as a reasonable limit to which they could scarcely object.

forces of native states are to
0,000, is not so important as
llisions between the British
ive states against that power,
ing the chances of any such
can be little doubt of our suc-
their nominal troops may be.
a combination of their forces
a view might easily mislead
e country in most fatal and

on of the vast disproportion
composing the British Indian
ies, with all their consequent

tates can produce a reduction
such a result would tend to
ilst it would confer immediate
ers and people of those very
rths of their present military
mode of dealing with this
e delicacy, but it is assuredly
aramount power in India it is
ause, whatever we may do or
nd justly, as the "paramount
our own territories or in the

uropean war, have for months
n with their inevitable and
of the empire and the well-
nost importance that such a
should at once be established
enable our statesmen to turn
the threatening catastrophe
and re-act between the heart
with the most sensitive preci-
particular quantity of good

ks.

tion in the arrangements for
military occupation of India
troops. The first desideratum
owd them. This can only be
the height, so that, when the
d that the floor will admit of,
cubic feet of interior space for
may be fixed at.
and its side space, and allow

8 feet between the opposite beds for the table and forms, and take 1,500 cubic feet as the interior space per man, we shall have 20 feet as the width of the rooms in the clear, and 37 feet the height.

If 1,200 cubic feet be assumed as the required breathing space per man with good contrivances for ventilation, then the height would be 30 feet.

If 1,000 cubic feet be the regulated breathing space, then 25 feet becomes the height. And, in all cases in the plains in India, barracks for Europeans during the summer should be furnished either with the punka or thermantidote.

There should be a ceiling of some description, with a free circulation of air between it and the exterior covering, to prevent the direct heat from the roof striking down on the men's heads. The roof should be carried down and similarly ceiled to within 8 feet of the ground, to form a verandah.

European Officers' Quarters.

115. There can be no question that regular barracks should be provided by Government for the European officers as well as the men. There can be no security or strength in the old principle of laying out cantonments which cover miles of ground, and render their defence impossible by any moderate force, when the contingency occurs of considerable proportions of the troops of a cantonment being suddenly required elsewhere.

116. The whole of the costly buildings required for Europeans ought to be compact and defensible, with a small force, against any sudden assault; and officers' quarters ought to be included.

It is often a source of considerable loss to officers to be obliged to purchase or build their bungalows in a cantonment. Their allowance in lieu of lodgings is no doubt on a very liberal scale; still there is no certainty of an officer remaining at the same cantonment until that allowance shall have reinbursed him for the building or purchase of his bungalow, which he may be unable to sell at his departure in consequence of a reduction in the strength of the relieving force.

117. This contingency sometimes embarrasses officers very much indeed. It should be taken into consideration, together with the heavy subscription to which young officers are subjected in the first years of joining their corps. Their allowances, however liberal for their rank as compared with English pay, are unable to meet such charges.

118. Debts to banks are contracted at usurious interest, and a plausible excuse is thus offered for commencing what grows into a discreditable, a ruinous, and, from the above causes, almost an unavoidable, habit in India.

This entire subject of officers' debts and their origin is well deserving of the closest investigation, with a view to the application of effectual remedies. There can be nothing more injurious to the character of Englishmen in the eyes of native Indians than the frequent exposures which it entails at courts of request.

It has had the most earnest attention of our best commanders, but its source was beyond their reach under the existing regulations.

119. The very gratifying transfer of the Company's army to the service

subordinate to Her Majesty's
is influence may enable him
move all shadows from the
vements as exhibited to the
pt that ascendancy won by
high moral qualities in the
he condition of the people

and must be practically a

be practically Commander-

en and must be practically

Chief in India have hitherto
India generally.
ch the offices of Governor-
lutely vested in the same

rt-comings in treating as it
cts.
y few will demur. That the
nable, and the establishment
tion of justice, and the free
best secure to Her Majesty
nd enable the future military
fe amount; whilst soundness
anization, and discipline of
that the resistless British
o so revolting and unequal a
rgone, in the defence of their
ts of her British and Indian

Evening Meeting.

Monday, January 31st, 1859.

Colonel the Honble. JAMES LINDSAY, in the Chair.

The Chairman announced that twenty-two Members had joined the Institution since the 1st January.

LIFE MEMBER.

Sir John Kirkland, Army Agent.

ANNUAL SUBSCRIBERS.

Lenon, Jno. F., Lieut. R.N.
James, Edw. R., Lieut. R.E.
Fellowes, H. P., Capt. Royal Marine L.I.
Baynes, R. L., C.B., Rear-Admiral
Elderton, Edw. M., Esq., late H.A. Comp.
Wade, Seaton, Surgeon R.N.
Best, M. G., Major 34th Regt.
Jay, John L., Esq., Sec. to the Gov. Greenwich Hospital.
Hastings, Jas. C. J., Esq., Clerk Ord. Dept.
Conolly, Jas., Lt.-Col. Ass. A. G. Portsmouth.
Sims, Andrew, Comr. R.N.
Lloyd, Wm., M.D., Staff-Surg. H.M. Indian Army.
Coles, Cowper P., Captain R.N.
Eliot, Chas. G. C., Lieut. Gren. Gds.
Farquhar, Arthur, Captain R.N.
Haultain, F. W., Captain Royal Art.
Heyland, A. R., Ensign 56th Regt.
Inglefield, S. H. S., Captain Royal Art.
Turnor, Geo., Lieut. 2nd Queen's.
Stanley, Hon. F. A., Lieut. Gren. Gds.
Tremayne, Arthur, Major 13th Light Dgs.

NAMES of MEMBERS who have paid increased SUBSCRIPTIONS since 1st January, 1859.

Wade, C. H., Lieut.-Col. unatt.
Gascoyne, C., Major-Gen.
Bennett, T., Rear-Admiral
Cochrane, Sir Thomas, Admiral
Drummond, John, Major-Gen.
Mayow, G. W., Colonel unatt.
Phillott, C. R. G., Admiral
Abbott, James, Esq., late Dem^{a}. Mil.
Stopford, J. J., Captain R.N.
Hill, R. J., Esq., late Lieut. 1st Royals
Nason, J., Major Dep. Batt.
Newenham, C. B., Esq., late Ord. Dep.
Inglefield, S. H. S., Captain R.A.
Jay, John L., Esq., Sec. to Gov. Greenwich Hospital.
Baynes, R. L., Rear-Admiral.
Bent, W. H., Capt. R. E. Mid^{x}. Mil.
Malton, W. C., Lieut. Edm. Royal Rifles.

DONATIONS.

	£	s.		£	s.
Monro, D. A., Maj. late 12th Lancers	1	0	Vyvyan, R. H. S., Lieut. Cornwall Rangers	1	1
Jefferson, R., Captain late Ceylon Rifles	1	0	Packe, Edm., Captain late R. H. Gds.	1	0
Blair, W. F., Capt. R.N.	1	0			

PRESENTS.

LIBRARY.

Books.

(The Donors' Names in Italics.)

Révue Militaire Suisse. 2 Vols. 1856-57. 8vo. Lausanne.
Presented by Chief of the War Department, Berne.

Cambridge Essays for 1858; contributed by Members of the University. Concluding the Series. 8vo. London, 1858. *Presented by Colonel R. A. Shafto Adair.*

Nos. 1, 2, 3, Journal Militaire, 1858. Large 8vo.
Presented by Minister of War, St. Petersburg.

Archives for the Officers of the Prussian Royal Artillery and Engineer Corps. 8vo. Berlin, 1835-58. 22 Vols. *Presented by Minister of War, Berlin.*

Science and Art Almanack for 1859. 3 copies. *Presented by Henry Cole, Esq., C.B.*

ponsibility.—The Royal Artillery.

General Sir R. Gardiner, K.C.B.

mission, &c. 1 Vol. 8vo. London,

Esq., C.E., F.R.S. (Hon. Mem.)

No. 8. January, 1859.

Presented by the Institution.

and the Recruiting Service, with

on, 1859. 8vo.

Presented by the Author.

t augmenté en 1806. Par P. G.

tre.

Presented by John T. Delane, Esq.

E. A. Corbet, Esq., 17th Lancers.

ys; Cartridge Box—obtained from

Formosa.

Brookes, R.N., H.M.S. Inflexible.

r to the front and one to the rear;

which the molten Iron has been

iangular mass in the centre; from

ntes, Esq., Depty. Ass. Comm.-Gen.

r Alexandria, in the immediate

Wilson, the 28th Regiment faced

21st March, 1801.

Capt. Maycock, Ast. Qr.-Mr.-Genl.

E. A. Corbet, Esq., 17th Lancers.

ESS.

n the honorable gentleman

the subject of this evening's

few words upon the occur-

st year with reference to the

he Institution has generally

which naturally strikes us

mber of members who have

8. It is a source of great

e satisfactory to all who are

t, with the exception of one

d the Institution during the

ve joined in any year since

enty-two new members have

siderable progress; but in one

d satisfactory than appears at

very great labor and exertion

year, without the slightest

s and the progress which we

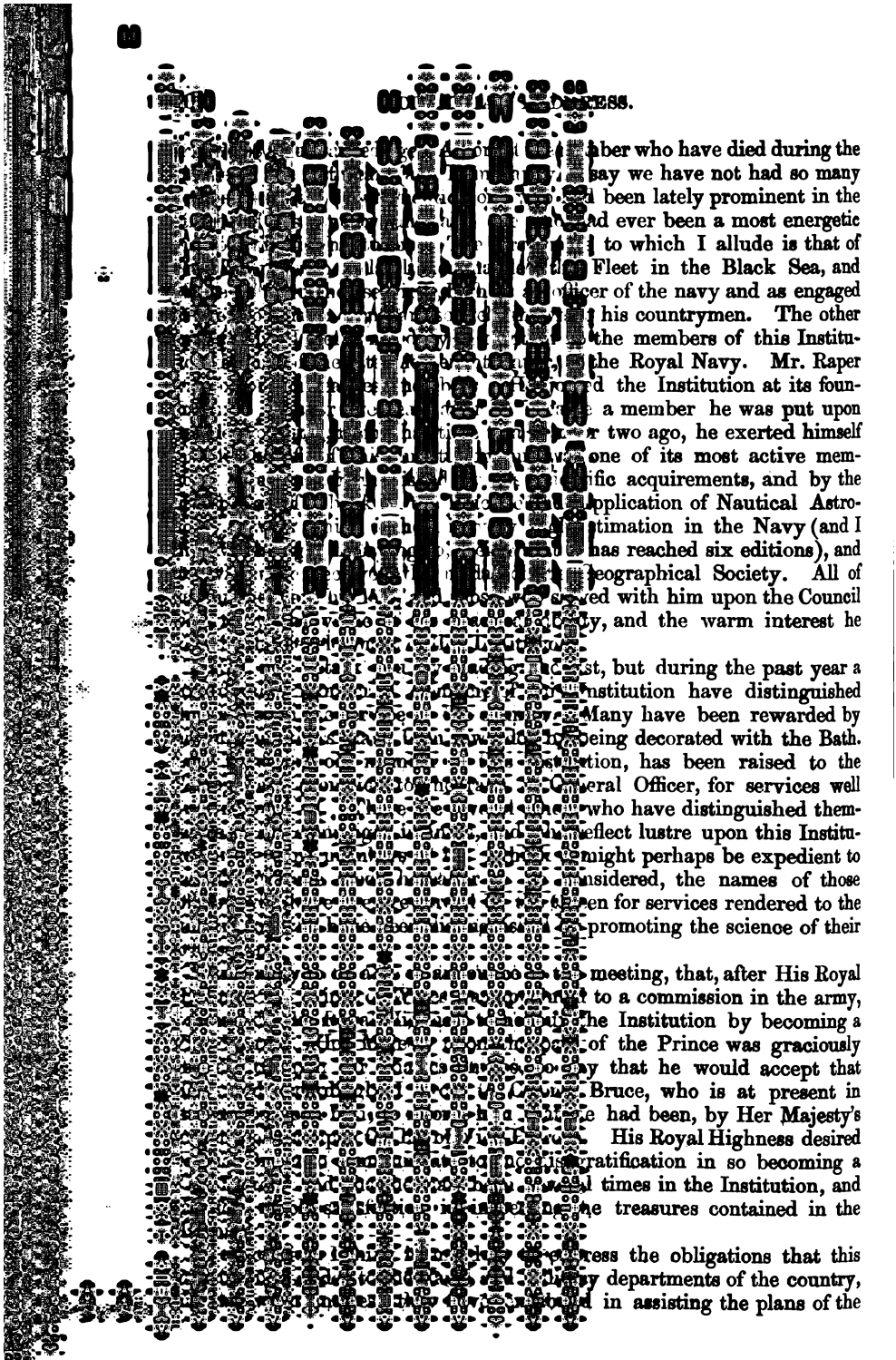
s of the Army and the Navy

ion, instead of our having to

canvass them. I hold this to be a great element of success, and I think there is every prospect of our seeing the same good feeling continued.

During the year no less than seventeen members have increased their subscriptions from 10*s.* to 1*l.*; and, though undoubtedly the number who have recently joined the Institution proves the increasing estimation in which it is held, yet, as regards an improved financial position, so far as it is dependent upon numbers, we have, in reality, great difficulties to contend with. The smallness of the subscription has hitherto compelled us to depend upon numbers; but, from the constant deductions by death and withdrawals, and, I am sorry to say, sometimes by arrears, and also from officers retiring from the Service ceasing to pay their subscriptions, we have not hitherto, unfortunately, made any very considerable increase in the total number of subscribers. Generally speaking, the number of members we gain during the year seldom exceeds the number we lose. The finances of the Institution have, however, been during the past year in a very prosperous condition in consequence of members increasing their subscriptions. The whole subject of the finance of the Institution will, in the course of this year, be brought before a general meeting, when I hope we shall be able to put our financial system upon a secure and permanent foundation. The principal cause of the last year being so successful as regards the increase of members, is the publication of the Journal ; and I am happy to say that the more the Journal has become known, the more highly has it become appreciated, more particularly by those serving in Her Majesty's ships and regiments in foreign parts. We have repeatedly received letters from officers serving abroad expressing their high appreciation of the Journal, and their anxiety to become members of the Institution. We also thought it a good opportunity of entering into communication with foreign countries, and we accordingly wrote letters to the representatives of foreign countries residing in this country, offering to transmit our Journal to their respective war departments, in the hope that they would transmit their naval and military magazines or reviews to our Institution. I may point to this table as the happy result of that request for the interchange of publications. The Prussian government have sent us twenty-two volumes of a military journal; the Russian government have sent us three of a military review; the Sardinian government have also sent us their military journal; we have something of the same sort from the Canton of Berne; and also three volumes from Copenhagen. We received at the same time the most handsome letters cordially concurring in the proposition which we ventured to make. If we were a rich body (and I hope that in the course of time by the exertions we are making we shall become so) one of our objects would be, where we found a paper of value in one of those journals, to reprint it and publish it in our own. For instance, very few people can read Russian, and, if there were a Russian article which might be considered to be an important one, that paper might be, with advantage, reprinted and circulated for our own members. Such a course would enhance the value of our Institution, by enabling its members to ascertain the opinions and progress of other nations.

During the last year, I regret to have to record, we have lost by death many very distinguished officers. Some of these were generals and admirals who had been engaged in the Revolutionary War, and who had



Council. We have increased the Museum considerably during the past year, by articles and specimens of a practical character, calculated to promote useful information among the younger members. Upon the part of the Council I will add, that we shall endeavour to persevere in the course which we are now pursuing. We are gradually obtaining the good-will and countenance of the two Services. Our progress cannot be rapid, for we have to overcome many difficulties ; we have to show and to prove that there is an Institution in the country which is capable of collecting and conveying professional information. Gradually the officers of the Service are perceiving, that the more they become acquainted with all the details and with the science of their profession, the greater is the estimation in which they are held, and the higher pleasure will they take in all that belongs to it. This Institution is not yet what it will eventually become ; but there are elements of success contained in its design, and when once a professional feeling is enlisted in its favour, which will, ere long, I anticipate, be the case, it will not fail to become worthy of the Services and the Nation.

NOTES ON THE MAGNETISM OF SHIPS,

By Frederick John Evans, Master R.N., F.R.A.S., Superintendent of the Compass Department, Admiralty.

The object of the paper I propose to submit to the Members of the United Service Institution this evening, is, to describe, in as brief and popular a manner as the subject will admit of, the progress and the present state of our knowledge of the magnetic condition of iron and wood built ships, and the consequent effect on the mariner's compass; together with the means at our disposal for analysing or detecting its character, as also by offering such illustrations as may be worthy special remark, and, by recording the sources of my authority, to direct attention to the theoretical labours of the several eminent men of science who have contributed to this peculiar branch of knowledge so important to a maritime community.

It is probably within the recollection of many of the Members of the Institution, that a lecture was given some seven years past in this theatre by the late venerable Dr. Scoresby, treating in part on the same subject, and which then excited interest among many nautical men from the novelty of certain principles expounded, and to which I shall have occasion hereafter to revert.

The great increase of iron shipping since that time—short comparatively as it is—in our mercantile marine; and the colossal dimensions to which they have expanded; the further general introduction of huge steam engines, boilers, and shafts into our now gigantic frigates and ships of the line, all tending to highly develop the magnetic conditions of those fabrics, is of itself sufficient to invest the subject with interest, setting aside the fact that more than one disastrous shipwreck within the same period of time can be distinctly traced to unsuspected, or unallowed-for compass errors.

It may be interesting here to observe that the varying influence of the

ss had sorely baffled many
r, as recorded in his voyage
at certain anomalies in the
ssing the Cape of Good Hope,
on.

who accompanied Cook our
discovery, stating distinctly
ad in different positions, and
differ from one another; and
rd different ships."

in the ship being the cause
y Mr. Downie, the master of
newly-invented compass, ob-
on in most ships has an effect
xperience that the needle will
placed in different parts of
steering the same course by
allel to each other; yet these
e ship, will agree exactly.

tigator, found, by a series of
ifferent parts of the ship, that
e before the centre of the ship
ariation; and on his return to
ence of his representation, di-
Sheerness on board several of
ome sound principles, but was
ed conditions to be generally

t received little attention till
l navy, published a valuable
Shortly after, in 1819, Pro-
e of experiments, with a view
n or correction for this source
will be found published, he
n placed near the compass, to
on lying before and below the
e of correction was successful
ch wrought-iron in the struc-
team-vessels, conditions arose
e of iron of a certain degree
cting plate has therefore fallen

me twelve to fourteen years
the then existing doubts as to
heir navigation from the pre-
ass, gave increased interest to
1835 the late Captain Edward
uperintendent of its Compass
Admiralty a series of experi-
ons burden, lying in the river

Shannon, with a view to ascertain the best position for the compass, as also the applicability of Barlow's plate.

It was then observed that the vessel acted as a permanent magnet on the compass and other magnetic instruments placed *exterior* to the vessel, and also that Barlow's plate failed as a corrector under the novel condition of its trial. Captain Johnson's paper and experiments in detail will be found among the *Philosophical Transactions* of the Royal Society for 1836.

In 1838 Mr. G. B. Airy, the present Astronomer Royal, also by the desire of the Board of Admiralty, conducted a series of experiments on board the iron vessels Rainbow and Ironsides, with a view to discover the laws of magnetic disturbance These experiments further determined that the *interior* of an iron vessel acted upon the compass as a permanent magnet. The results, accompanied with elaborate investigations, are published in the *Philosophical Transactions* for 1839, and a popular account of the same experiments, and deductions therefrom, were afterwards given by Mr. Airy in the *United Service Journal* for 1840, and also separately published by Mr. Weale of Holborn in the same year, with practical rules added for neutralizing the ship's disturbing force by the introduction of new and antagonistic disturbing forces in the shape of bar magnets and masses of soft iron.

Mr. Airy resumed the subject in later years, as additional records of observations in various parts of the world came under his notice, and a highly instructive (though in parts necessarily abstruse) paper was communicated to the Royal Society in 1855, and published in their *Transactions* for that year.

Preparatory to entering on the nature of and the laws affecting the magnetism of ships, it may not be considered irrelevant to touch concisely on a few of the general features of Terrestrial Magnetism, and I the more readily invite your attention to it, as bearing directly on the subject under review, and also as being one of those branches of science that should be acquired, at least in its general principles, as a necessary part of nautical education. In support, I may quote from the writings of one of the greatest philosophers of our time (Sir John Herschel): "Among the great branches of science which the present generation has either seen to arise as of new creation, or to spring forward by a sudden and general impulse into a fresh and more luxuriant state of development, there is none more eminently practical in its bearings and application than that of Terrestrial Magnetism."

Magnetism has been happily described as one of those unseen existences which, like electricity and heat, is only known by its effects. The magnetic condition of our globe is manifested at its surface by the three elements known as the Variation, Dip, and Intensity. The two former terms are, however, seldom used in scientific discussions, having given way to the modern appellations of Magnetic Declination and Inclination. The original and more simple names, which are familiar to every sailor, I propose to retain in this paper.

We may define the magnetic Variation as the amount by which the pointing of the compass-needle differs from the true geographical north; the magnetic Dip as the line of inclination to the horizon of a freely sus-

pended needle, not limited in motion only to the horizontal plane, as is the compass-needle; the Intensity as the amount of magnetic force acting on the freely suspended needle, and giving it its direction. This latter element may be resolved into two components, one acting on the horizontal, the other in the vertical direction.

The Variation is in most parts of the globe undergoing continual change, partaking of an annual as well as a diurnal variation. The latter follows a general law in either hemisphere: in the northern, the movements of the north pole of the needle from about 8 A.M. to 1 P.M is from east to west, it then becomes stationary, and with a slow motion retrogades to the east, arriving at the original point about 10 P.M., a smaller oscillation being observed during the night; the movement in the southern hemisphere is reversed in direction. The amount in angular value varies in different latitudes, and according to the seasons; in northern Europe it attains 15′ or 17′.

The annual change varies in different regions; at the present time (1859) in Great Britain the average decrease is about 6′. On the eastern coasts of America, nearly in the same parallel, it appears to be increasing by a similar amount.

I may take this opportunity of submitting for your examination a Variation Chart of the World,* which has engaged my attention for several months, and which has just been published by the Admiralty. It results from numerous observations made by the officers of H. M. navy, chiefly between 1850 and 1858, also from various magnetic surveys undertaken by the British and Foreign Governments.

The dip of the magnetic needle engages but little the attention of seamen, though it is familiar to them that the compass-needle does not retain its horizontality on great changes of latitude, excepting through the medium of adjusting-weights. As the dip is an important element in the consideration of the changes of the magnetic condition of all vessels, but especially of iron ships, a brief account of its nature and distribution is necessary. The term magnetic poles is generally applied to those positions on the surface of the earth where the horizontal force disappears, and a freely suspended needle becomes vertical; the same end of the needle pointing in opposite directions in either hemisphere. In like manner the term magnetic equator is applied to those places where the needle has no inclination or dip, but rests in an horizontal direction: this line of no dip is irregular, and of double flexure, cutting the geographical equator in four points, and inclined to it generally at an angle of 12°.

The dip increases gradually on either side of the magnetic equator, and the lines of equal amount are nearly parallel to it till within the vicinity of the magnetic poles. A ship sailing along one of the lines of equal dip, is said to remain in the same magnetic latitude, and she changes her magnetic latitude most rapidly when her course is at right angles to those lines. The dip, like the variation, is subject to secular change; the annual decrease in the British Islands, and over a great part of Europe, has averaged, for several years past, about 3′; in the South Atlantic Ocean it is increasing about 6′ annually.

* Presented to the Library of the United Service Institution.

The intensity, in a philosophic point of view, is the most interesting element of terrestial magnetism, as from its general investigation fruitful results in respect to the theory are anticipated; and it is practically useful for the seaman to know that the magnetism of his ship may be proportionally affected according to the regions of greater or lesser intensity passed through.

An ordinary and simple method of determining the intensity, is by vibrating a freely suspended dipping needle, which is acted on by the magnetic force of the earth in a similar manner to that in which the pendulum is acted on by gravitation: the squares of the number of vibrations in a given time at various places give the ratio of the intensity at those places. By the application of a more refined and difficult method, the absolute values may be determined; these values may be defined as a series of numbers representing the ratio of intensity to a given unit for every point of the earth's surface, and are represented on a chart by lines of equal value (*isodynamic* lines), similar to the variation chart submitted for your inspection.

An investigation of the lines of equal intensity tends to these results, viz., of there being two foci, or points of maximum force, in either hemisphere. These foci are of unequal force: the greatest in the northern hemisphere is in North America, the weaker in the north of Siberia: the corresponding phenomena in the southern hemisphere are not determined with the same precision, but appear to have the same general characteristics. As a general rule, the magnetic intensity is least near the equatorial portions of the globe, and greatest in the polar—the vicinity of St. Helena appearing to have the smallest amount yet discovered.

Having thus noticed those elements of terrestrial magnetism necessary for a correct appreciation of our subject, we may now enter on the consideration of the theory of the magnetism of ships:—The errors of the compass on board ships arise from two distinct sources of magnetism; the one transient, induced in the soft iron of the vessel; the other permanent, originating in the rolled and hammered iron (differing from the condition of soft iron) employed in the construction of the hull and machinery.

Induced magnetism is due (1st) to the magnetic action of the earth, whereby every particle of "soft iron" is converted into a magnet, whose direction is parallel to that of the dipping needle, and which magnetic power it loses on removal from that influence; and (2dly) when exposed to the influence of any magnetic body, which induced magnetism it loses when the influencing body is removed.*

By permanent magnetism is understood the property of attraction and repulsion belonging to a mass of hard magnetized iron, whatever may be its position; thus differing from induced magnetism, which, as stated, (1st) only acts in the line of the dip. "Hard iron" does not under ordinary circumstances become magnetic by induction; but when mag-

* The action of the earth on the north end of the needle is exerted in the direction which is called the *line of force*. This is the direction of the dipping needle, viz., towards the magnetic North, but inclined to the horizon at an angle equal to the magnetic dip, at the place—in England about 68° below the horizon. A bar of soft iron held in the direction of the line of force of the earth becomes instantly magnetic.

netized it retains the magnetic power even after the influencing body is removed, thus also differing from the induced magnetism of "soft iron," (2dly), which vanishes directly the influencing body is removed.

We have now to consider the action of induced and permanent magnetism separately on the compass-needle, and which can be illustrated practically by using iron bars of either quality. Employing a hard iron bar magnetized, and placing it in a direct line north or south of the compass-needle, with that end which attracts the north end of the needle being placed nearest the centre of the needle, it will be found to produce no deviation; when due east of the needle (as disturbed) it will cause a maximum easterly, and when west, a maximum westerly, deviation.

Note.—If we project the curve resulting from this experiment on the face of a compass-card, or from a straight line divided into 32 points, it will assume the form of figures 2 and 2′. (Plate I.)

The effect of a bar of soft iron on the compass-needle is more complicated, depending (1st) on the direction and amount of the dip at the place of observation; (2dly) on whether it is placed in a vertical or horizontal direction. In north magnetic latitudes, if placed in a vertical position, the upper end attracts and the lower end repels the north point of the needle; in south magnetic latitudes the reverse occurs: on the magnetic equator where the dipping-needle assumes a horizontal position, the vertical bar of soft iron will cease to be magnetic. The effect on the compass arising from this vertical portion of the earth's induction on soft iron is so far the same as that arising from the permanent magnetism of hard iron as to attract the north end of the needle as the ship swings round; but with a varying amount of attractive power proportional to the tangent of the dip, which latter magnetic element, as is generally familiar to seamen, rapidly alters in passing from north to south, or *vice versâ*, over the globe; whereas the attractive force of the permanent magnetic bar varies in an inverse proportion to the horizontal magnetic intensity, and diminishes therefore for example between England and the Cape of Good Hope in the proportion of 20 to 16. This part of the deviation arising from the combined effects of permanently magnetic iron and of magnetism induced in soft iron by the vertical part of the earth's force, is termed by Mr. Airy "polar-magnet-deviation."

The nature of the change in the deviation produced by the permanent and induced magnetism respectively, on a change of magnetic latitude, is thus described by Mr. A. Smith, a high authority on magnetic science—

The first varies inversely as the horizontal force; the second varies as the tangent of the dip; their changes in different magnetic latitudes may be thus described: at a magnetic pole of the earth when the dip is 90°, and the horizontal force zero, each part becomes infinite:—this indicates that there is then no directive force.

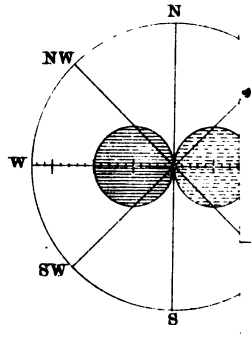
For some distance from the magnetic pole, the two parts change nearly at the same rate, and therefore the whole varies nearly as the tangent of the dip; but as we approach the magnetic equator, the part which arises from the soft iron diminishes the most rapidly. It becomes zero at the equator, and in south magnetic latitudes has the same value as in corresponding north magnetic latitudes, but the opposite sign. The part which arises from the hard iron does not become zero at the magnetic equator, but becomes a minimum at that line, nearly coincident with the magnetic equator, at which the horizontal force is a maximum, and in south magnetic latitudes it has the same sign and nearly the same value as in northern.

ions

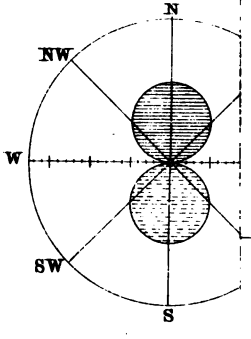
POLAR DEVIATIONS

QUADRANTAL DEVIATIONS

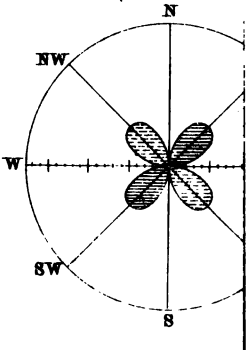
Nº 1. Attraction towards



Nº 3. Attraction towards Sta



Nº 5. Plus Quadrantal

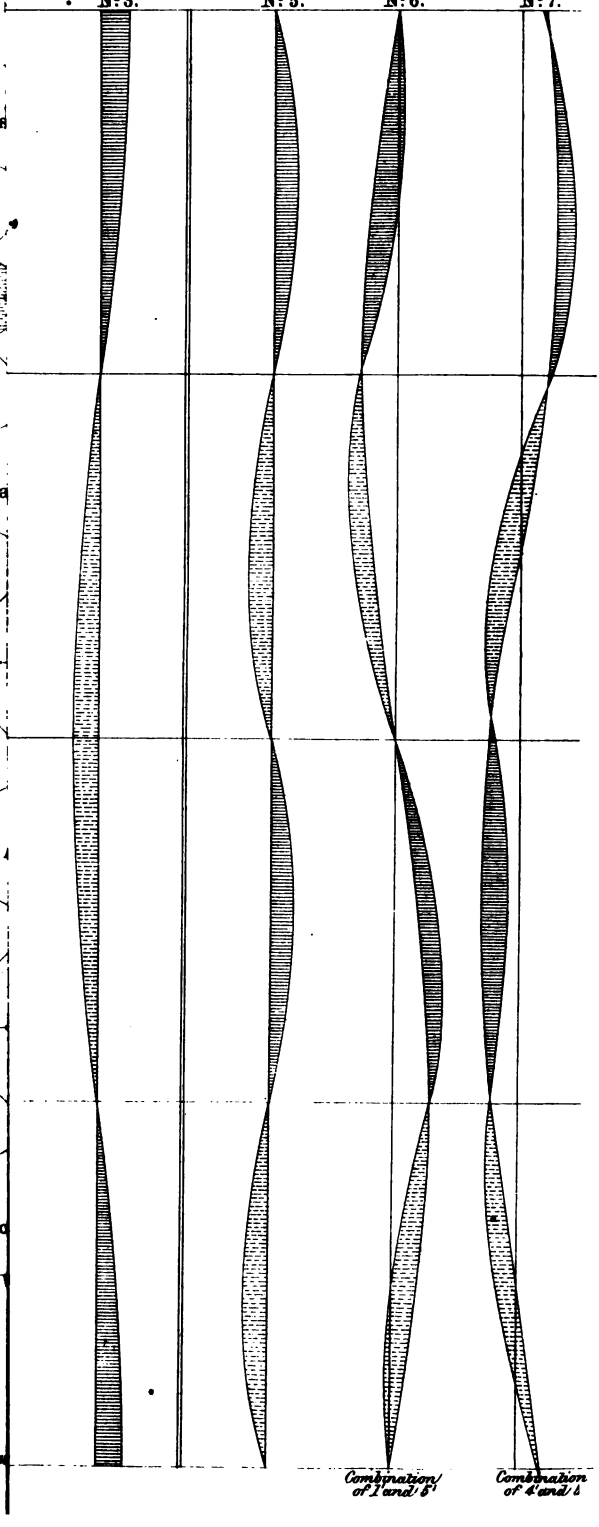


Nº 7. Combinatio

Note. *In all the*

Quadrantal Deviations

Nº 3'. Nº 5'. Nº 6'. Nº 7'.



A horizontal bar of soft iron placed at the same level as the compass-needle, and in the same fore and aft line, produces a deviation as the ship swings round which has been termed by Mr. Airy "quadrantal," from changing its character in each quadrant of the compass: thus, an easterly deviation occurs when the ship's head is between north and east; westerly when between east and south; easterly deviation again between south and west, and westerly with the ship's head in the remaining quadrant: the maximum amounts of deviation being at N.E., S.E., S.W., and N.W., and the points of no deviation at north, south, east, and west. The reason of this action is readily explained: when the bar is at right angles to the magnetic meridian, or in a direction east and west to the line of the keel when north and south, it ceases to be magnetic; in any other position its south end attracts the north end of the needle and its north end repels it. But if the bar be placed in the line of the keel with the ship's head north and south, though it attracts the needle, it does so in the direction in which it points, and therefore produces no deviation: the chief action is therefore on the intermediate points.

Note.—By projecting the curve resulting from the experiment as just described, it will assume the form of fig. 5. Plate I.

It is especially worthy of note that the quadrantal deviation of the compass resulting from the combined action of the fore and aft horizontal portion of the soft iron in the ship is independent of locality, remaining the same in all magnetic latitudes.

Having laid before you the characteristic qualities of permanent and induced magnetism, it is now necessary to consider their combined action:—if the magnetism of a ship was due entirely to the action of "soft" iron and "hard" iron, it would be possible by observations made in any two magnetic latitudes to determine the values of their parts separately; or theoretically from observations in the one geographic position to deduce the values in any other, as their laws of change have been fully investigated. But it will readily be conceived that a large portion of the iron entering into the composition of a vessel must vary in its nature between the extremes of "hard" and "soft." The magnetism of this iron in an intermediate state has been named "subpermanent," or "retentive;" and it is from the combination of the permanent and induced being apparently so inextricably mixed up that to determine the value of the two portions separately by theory appears impossible. Other features also present themselves, for it is considered that the conditions of subpermanent magnetic iron are liable to change from blows or straining of the vessel; and General Sabine has pointed out in his valuable contributions to Terrestrial Magnetism, No. IX., (see *Philosophical Transactions* for 1849,) that the changes of magnetism corresponding to changes of the ship's place are gradual rather than instantaneous, or in other words that this portion of the magnetism depends not only on the place where the ship is, but where she has been for some preceding days or weeks.

Bearing the foregoing laws and facts in view, it will be understood how the deviations of the compass vary in character in different vessels on changes of geographic position:—In wood-built vessels, and especially

sailing-ships, where soft iron predominates, the changes are due to induced magnetism; hence the deviations diminish as the magnetic equator is approached, and change their direction on passing into a south magnetic latitude.

In iron-built vessels where permanent and subpermanent magnetism predominates, the changes of deviation are less regular, and the deviations may retain the same direction in both hemispheres. This is fully exemplified and borne out by examinations I have made of the numerous Tables of Deviations annually transmitted from H.M. ships.

For many years the Admiralty have published Practical Rules for ascertaining the deviation of the compass caused by the ship's iron, and which are doubtless familiar to most or indeed all naval officers. In 1851 the Hydrographic Office published the first, and in 1855 the second edition of a supplement to these practical rules. This useful and highly interesting little work (a portion of which I propose especially to bring to your notice) is supplied to H.M. Ships. The maritime profession is indebted to Mr. Archibald Smith, M.A., F.R.S., of Lincoln's Inn, and late fellow of Trinity College, Cambridge, for this highly valuable contribution to navigation.

The part I wish to allude to, is an instructive process to analyse numerically the various portions of a ship's magnetism due to the laws already explained, by which we are enabled to enter on an investigation of, and generally to account for, any peculiarities in the deviations of the compass of particular ships.

A deviation table having been formed by any of the processes now so generally understood, either on the thirty-two points of the compass, the sixteen intermediate, or the eight principal points—the values of five separate coefficients are deduced therefrom by the aid of mathematical formulæ, which latter have been much simplified in practice by neat tabular arrangements, appended blank forms, and with clear examples.

The five coefficients are distinguished by the letters A, B, C, D, E, and represent the values of the magnetic disturbance for each compass.

D and E are termed the "permanent coefficients," as they are presumed to preserve their values unchanged in all parts of the globe.

B and C are coefficients which change on a change of geographic position, especially of latitude, and it is considered in a way generally impossible to be predicted, and as also to change from extraneous causes.

It is important to describe these coefficients in detail:—The coefficient A is a constant error, it includes any correction which may be due to index error of the standard compass, or the shore compass employed in observing the deviations, or to—a not unfrequent cause of error—the lubber-line of the former not being exactly fore and aft: whatever portion is due to magnetism arises from a peculiar non-symmetrical arrangement of soft iron in the immediate vicinity of the compass only likely to occur in small vessels. This coefficient is in general small: + sign denotes the easterly deviation is in excess; — sign the westerly in excess.

D and E are due to the "quadrantal" effects of the horizontal parts of the soft iron:—the values of D are from that portion acting in the fore and aft or athwartship lines; + sign is due to masses before or abaft the com-

pass; — sign to masses on starboard or port side:—the values of E are from masses of soft iron in the intermediate angles.

D has in general a positive value, and is large in amount, varying from 2° to 5° in most iron vessels. E is in general very small.

B and C, the changing, and generally the largest coefficients, are due to the combined effects of the permanent magnetism of the hard iron, and that induced by the vertical part of the earth's force in the soft iron, of which the separate laws of change have been already described:—B represents that part of the combined attraction acting in a fore and aft direction, + if before the compass, *i.e.* the north end of the needle is drawn towards the *bow*; — if abaft it, *i.e.* the north end attracted towards the *stern*. C that portion acting in an athwartship direction, + if north end of needle drawn to starboard, — if north end of needle drawn to port.

Not the least valuable part of a knowledge of the five coefficients is, that a table of deviations can be constructed from them, by which, whatever original errors of observation may have existed on few or many points of determination, these errors are then divided over the whole thirty-two points of the compass.

In illustration of the principles of a ship's magnetism, and the value of this numerical analysis in determining its character, the case of H.M.S. Sanspareil, of 71 guns, is deserving attention: the funnel of this ship is on the quarter deck, and distant from the standard-compass in its usual position on the break of the poop only 19 feet 4 inches; consequently there must be a lively affinity between them. In the Sanspareil's early equipment the funnel was of copper, and the deviations were small in amount, not exceeding 6°. In 1856, an iron funnel was substituted, when the maximum deviation in England amounted to 24°.

In the voyage to the Cape of Good Hope, Captain Key observed the deviations to alter considerably, and on arrival in port the ship was reswung, and the deviations found to have decreased to a maximum of only 4°.

This was unquestionably a striking change, and in less careful hands might have been a source of much embarrassment. In an interesting letter to the Hydrographer calling attention to the subject, (which will be found in the Nautical Magazine for October, 1857,) Captain Key considers that the deviation of the needle is due only to the induced magnetism of the iron on board, and that its direction is regulated by the position of the poles of that iron.

By employing Mr. Smith's formulæ, we are better enabled to judge of the general character of the magnetism of the Sanspareil, without risking any hypothetical opinions.

Computing the coefficients from the Sanspareil's deviation tables observed in England and at the Cape of Good Hope, with the funnel down, (which brought it nearly on a level with the compass-needle,) we have the following results:—

	A	B	C	D	E	Dip.	Nat. Tang.	1 / Hor. Force.
Plymouth	+0° 4′,	+23° 43′,	+1° 45′,	+0° 58′,	−0° 13′,	68° 40′	+, 2·60.	2·04
Cape of Good Hope	−0 37,	+ 3 41,	+2 08,	+1 16,	+0 36,	54 00	−, 1·38.	1·66.

Here it is obvious that the permanent coefficients may be considered —

taking into account the probable small errors of observation—to have stood the test of theory, and that the effect on the changing coefficients is due to the combined action of permanent or polar-magnet deviation and induced magnetism. Were the deviations of the Sanspareil's compass due alone to the induced magnetism of the funnel and guns as surmised by Captain Key, the cofficient B would have differed from the amount in England (+23° 43′) in the proportion of the tangent of the different dips, or as 2·6 to −1·4, giving a result of −18° 45′ instead of +3° 41′. Were they due to permanent magnetism alone, B would have differed from its amount in England in the proportion of 2·04 to 1·66 (values deduced from Gauss's chart of magnetic intensity) giving a result of +18° 58′ instead of +3° 41′. As the value of B deduced from the observation at the Cape, viz. +3° 41′, lies between the two values above deduced, we may infer that the polar-magnet deviation was caused in nearly equal proportions by the permanent or subpermanent magnetism and the induced magnetism.

The accompanying coefficients of two wooden sailing vessels, and two iron steam-vessels, as computed from observations made in England and at the Cape of Good Hope, are instructive examples of the changes according to the theory advanced.

H.M.S. Herald (Surveying Ship).

	A	B	C	D	E
	° ′	° ′	° ′	° ′	° ′
River Thames, May, 1852	×0 5,	+2 6,	−0 7,	+0 15,	0 0
Cape of Good Hope, Nov. 1852 .	−0 13,	−1 45,	0 0,	+0 9,	+0 15,

H.M.S. Mæander (40 guns).

Sheerness, September, 1852 . . .	−0 15,	+1 10,	+ 0 30,	− 0 15,	+0 8
Cape of Good Hope, March, 1853	−0 23,	−2 35,	− 0 3,	−0 10,	+0 6

H.M.S. Simoom (Iron Troop Ship).

Portsmouth, September, 1852 . .	−0 7,	+20 07,	− 7 18,	+4 33,	−0 19
Cape of Good Hope, Oct. . 1853	−1 47,	+13 06,	− 2 23,	+4 13,	+0 22

H.M.S. Vulcan (Iron Troop Ship).

Portsmouth, July, 1852	−0 13,	− 8 47,	+0 43,	+3 37,	−0 44
Cape of Good Hope, Feb. 1853 .	+1 8,	−16 3,	+1 19,	+4 15,	+0 51

On Deviation Curves.

Graphic projections of the deviations of the standard compass are not only useful in practice, but serve as a simple and ready mode of obtaining a table of probable deviations for every point of the compass from observations made on a few points only, and particularly for illustrating the nature of the ship's magnetism, whether polar-magnet, or quadrantal, or the two combined. The earliest in point of date will be found in the supplement to the Admiralty Practical Rules, and is due to Mr. R. J. Napier of Glasgow; the second by Captain A. P. Ryder, of the Royal Navy, is similar in principle, though simplified for seamen in a part of its application; and the third, designated the "straight line method," is due to

Mr. A. Smith, F.R.S., and appended to the Board of Trade instructions for correcting the deviations of the compass.

The chief object of Mr. Napier's method is to determine the amount of deviation for each of the 32 points of the compass, from observations made on a few detached points (without entering into the diffuse calculations otherwise necessary), by tracing a curve deviating more or less from a straight line, which may be considered as the margin of a compass-card, cut at the north point and straightened:—the difference between the curved and straight lines gives at once a clear idea of the amount and character of the disturbing effects of the ship's iron. The exact conversion of compass courses into correct magnetic courses, and *vice versâ*, follows as an invaluable part of the method.

Captain Ryder's plan has more particular application to the conversion of courses, as, from mere inspection of the curves of deviation as drawn on his projection, correct magnetic or standard-compass courses and bearings can be at once obtained, and with little possibility of error. Mr. A. Smith's straight-line method will also be found a simple and convenient plan for tabulating the results of the observations, and of making the "course" corrections.

Captain Nolloth, of the Council of this Institution, has also exhibited before you and explained a Deviation Diagram; it is given in the first volume of the Journal of the Institution, accompanied with these remarks: "It appears that by this method of graphical delineation a convenient means is afforded of comparing various forms of deviation curves, and of considering them in connection with the circumstances of magnetic influence under which they respectively occur."

In the accompanying diagrams, Plate I. projected both on Captain Nolloth's circular plan, and a simple adaptation of Mr. Napier's method, you will readily distinguish the characteristics of polar-magnet deviation (*i.e.* permanent magnetism and vertical induction) and quadrantal deviation; but it must be recollected that practically these two are combined in every variety of manner.

The easterly deviations are denoted by *hatched* lines, the westerly deviations are denoted by *dotted* lines.

Fig. 1 and 1′, represents polar deviation alone, where the attraction is towards the ship's *stern*.

Fig. 2 and 2′, polar deviation alone, where the attraction is towards the ship's *bow*.

Fig. 3 and 3′, polar deviation alone, where the attraction is towards the ship's *starboard side*.

Fig. 4, polar deviation alone, where the attraction is 4 *points on starboard bow*.

Fig. 5 and 5′, quadrantal deviation (+) giving easterly deviation in the N.E. and S.W., and westerly deviation in the N.E. and S.W. quarters. Fig. 6 and 7 and 6′ and 7′ are combinations of the polar and quadrantal; fig. 6 being 1 and 5 combined, fig. 7, 4 and 5 combined. In these two latter diagrams on Napier's method only the quadrantal excess or deficiency has been tinted.

I have now to bring to your notice, and under review, the valuable

labours, still in progress, of a Committee formed at Liverpool by various gentlemen connected with the vast shipping interests of that port, and working also under the auspices of the Board of Trade, to collect observations and make experiments on the condition and distribution of magnetism in iron-built ships, and the general system of compass correction and management.

Two or three disastrous shipwrecks, clearly traced to compass errors, occurring about the time that the iron navy of Liverpool was rapidly expanding, gave rise to various conflicting opinions on the safety of their navigation, and particularly on the subject of compass-compensation by magnets; these questions were discussed in various periodicals, and also at the British Association for the Advancement of Science, held at Liverpool in 1854: hence arose the formation of the Liverpool Compass Committee.

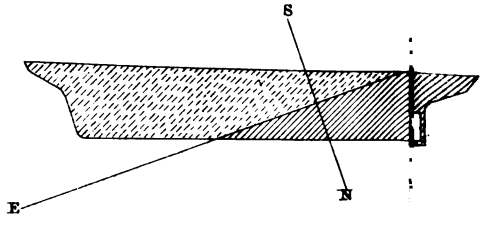
The publication in 1857 of the First and Second Reports of that body to the Board of Trade, and presented to both Houses of Parliament by command of Her Majesty, enables the observations relative to the theory of the magnetism of ships to be extended, not only in confirming what has been already advanced, but in giving some more general views of its character and distribution, particularly in iron-built vessels.

A striking feature in these Reports is, that the researches of the various authorities already quoted, and their exposition of the laws of magnetic action on ship-board, have received ample confirmation from the various observations collected and experiments undertaken by the Committee. In the opening page of the Second Report they observe, that it has been "proved, too, most decisively, that the deviations of the compass on board iron ships, when properly ascertained, are not of that irregular and erratic character which many cards of deviation might lead one to suppose, but that they accord most closely with the deductions of theory and experiment, as exemplified in the works of the Astronomer Royal and Mr. Archibald Smith." And again, at p. 24, in alluding to certain fluctuations in the amount and direction of a ship's induced magnetism,—"These fluctuations do not appear, however, to affect *practically* an authoritative statement which has already been supported by the Committee, and which, as it forms the key to the correction and calculation of compass deviations, cannot be too earnestly repeated; namely, that a ship's magnetism for any given place may be very closely represented by a permanent polar magnetic force in combination with a quadrantal force, or one changing its deviation in each quadrant as a ship is swung round."

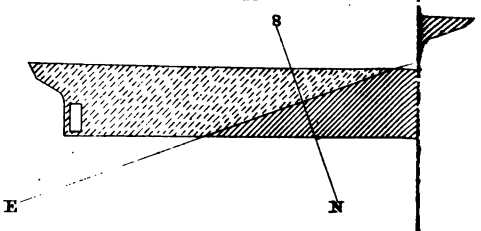
Among the various philosophers who, during the present half century, —a period noted for the progress of theoretical and experimental research— have grappled with the perplexing and it may be said uninviting science of magnetism, none more perseveringly worked for practical ends than the late Rev. Dr. Scoresby, and to him is due the enunciation of the notable facts, that the distribution of magnetism in an iron ship depends on the direction of the keel and head while building with reference to the magnetic meridian; and that this original magnetism is subject to great changes after launching, and also from other extraneous causes. The following from among the results of his investigations, as bearing on the subject, are worthy of extract.—(*Magnetical Investigations, by the Rev.* Wm. Scoresby, D.D., vol. ii. 1852, pp. 330—343.)

THEORETIC MAGNETIC CONDITION OF IRON SHIPTING FROM
THE DIP OF THE NEEDLE FROM 68° TO
TO BEING LAUNCHE
(according to the late Dr Sc

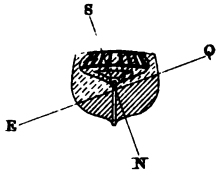
Head South.



Head North.



Head West.



The axial line S.N. in each figure represe
Dip or line of magnetic force as passing
centre of gravity of the material of the s
All below the equatorial line E.Q. shade
Northern polarity; all above it, shaded w
Southern polarity.

no Variation.

1. That ships built of iron, in place of timber and plank, obtain necessarily *an extremely high degree* of magnetic development from the elaborate system of percussive action, as well as from the bending of the plates and bars, during the progress of their construction.

2. That the dominant magnetism thus developed is of the *retentive quality*, a quality remaining whilst terrestrially sustained by consistency of position, and otherwise, also, in relations inaccordant with terrestrial influence, whilst the ship remains free from mechanical violence or other magnetically disturbing force.

3. That in each iron ship there is a special individuality of the magnetic distribution, depending *essentially* on the position—characterised by the direction of the keel and head—whilst building, and *peculiarly* on the deviations from uniformity in the placing of occasional heavy masses of iron.

4. That, after being launched, percussion, vibration, or the straining of the general frame of iron-built ships, must *tend* to equalise the relations of the ship's magnetisms with with those of the earth; and that the state of equalisation, or approximation thereto, will be hastened and advanced, accordingly as the quantity or intensity of mechanical violence is increased, and accordingly as the ship's head is kept pretty steadily in the same direction.

The accompanying diagrams (Plate II.) represent, according to Dr. Scoresby, the theoretic magnetic condition of iron ships built in England, with the dip of the needle from 68° to 70° N., previous to being launched.

The confirmation of Dr. Scoresby's views will be seen from the following extract. "The records of the Committee no longer allow a doubt as to the connection which exists between the direction of a ship's original magnetism and her position when upon the building slip. In all the ships which have been examined, the north end of the compass-needle invariably deviated towards that part of the ship which was farthest from the north while she was building, if the compass was placed in a central position, and free from the influence of individual masses of iron."*

The Reports also further proceed to show that the characteristic features of the original magnetism of an iron ship, by which is meant the magnetism dependent on her direction when building, and the effect on a compass when she is swung, presuming that the needle is not influenced by iron bulk-heads, or proximity to the stern-post, rudder-head, or other masses of vertical iron controlling the magnetism of the hull of the ship, is as follows:—

In an iron ship built with her head to the north, or nearly so, there is no apparent attraction of the needle towards either side while she lies in a north or south direction: but with her head in all other directions there is a strong attraction towards the stern.

With ships built head to the south, the same principle will apply, the deviation being then towards the bow.

When built with head to the east, the deviation is towards the starboard side, (the south in building) and when built with the head to the west, to the port side, (the south in building): [this deviation must be considered as only due to a differential action, for if a compass be placed near the top sides of such ships either internally or externally, the north end of the needle (in north magnetic latitudes) is attracted; one side however attracts the needle more strongly than the other, and that is the side which was

* This is exemplified by the diagrams Plate 2, which represent the magnetic character of various vessels as determined by actual experiment at Liverpool while they were in dock.

furthest from the north when the ship was building, as above stated.] In these vessels if placed in an east or west direction, the north end of the needle will tend to the bow or stern respectively according to the direction in which lies the greater mass of iron.

In ships built in intermediate positions the preceding characteristics are combined; thus, if built with head to the N.E., the attraction will be aft and to starboard; with the head to the N.W., aft and to port. If the head be S.E. or S.W., the attraction will be forward and to starboard, or forward and to port respectively.

The *amount* of original magnetism appears to have relation to the size of the vessel, or the quantity of iron used in her construction, and is thus illustrated:—"In a ship of 400 tons, built head to east, if a compass be carried fore and aft on the middle line, about three or four feet from the deck, the deviation may be 10° or 12° when her head is north or south. In a ship of 1,000 tons it may under the same conditions be 25° or 30°, or more, depending to some extent on the breadth of the ship."

From a consideration of the foregoing illustrations, we may at once predicate the character of an iron ship's deviation from a knowledge of the direction of her keel and head when building, or, *vice versâ*, from having her deviation table we may infer the direction in which she was built: the accompanying table illustrates generally these conditions. Thus if

Approximate direction of ship's head (magnetic) while building is,	Maximum Easterly deviation when ship's head is near.	Maximum Westerly deviation when ship's head is near.
North.	West.	East.
N.E.	N.W.	S.E.
East.	North.	South.
S.E.	N.E.	S.W.
South.	East.	West.
S.W.	S.E.	N.W.
West.	South.	North.
N.W.	S.W.	N.E.

We have now arrived at an important feature of the inquiry—the alteration in the ship's magnetism after launching—and which would still appear to require an extended series of experiments to elicit more precise information. Numerous examples are given by the Committee, but derived more from information communicated than from direct experiment; still there is a notable example deduced from the latter in the case of the ship Royal Charter, which will be hereafter alluded to. The conclusions arrived at are thus given:

This original magnetism of an iron ship is frequently very permanent as regards direction, but is believed to undergo rapid changes in its amount, both in reality and in its apparent effect on the compass: the most striking change being at and immediately after launching, and during the first voyage. It is usually more evident in a steamer than in a sailing vessel. There are cases in which the deviations in a steamer have changed so much as two points in the first two days at sea, while afterwards the change has not been more than 3° in as many months. In new sailing ships the change is generally, but not always, more gradual, and extends over a longer period. A change of 10° to 15° is not infrequent.

Again, Under some circumstances considerably more than one half of a ship's original magnetism, or rather that part of it which affects the compass, may be lost, or may become balanced in the course of a year.

And, After this early reduction of a ship's magnetism has taken place, the remaining portion, as far as may be judged from examinations made in the same place, and under the same circumstances, appears to be comparatively permanent.

In confirmation of this comparatively permanent condition of a ship's magnetism the Committee give a striking example in the case of the ship Great Britain; and it may be permitted me to express my opinion, having had the opportunity of inspecting deviation tables of most of the iron vessels in H.M. navy, extending over many years' observations, that from this evidence also their permanent condition appears to be the rule.

The Committee thus report on that well-known iron ship the "Great Britain:"—

This extraordinary ship has been stranded, and strained, and altered; has traversed both hemispheres, and been very many years in active service: yet her lines of no deviation are now much the same as Dr. Scoresby would indicate them to have been when she was upon the stocks. Yet how small is the change! a proof, apparently, that no circumstances can permanently *conceal* or greatly alter the direction of an iron ship's original magnetism.

[Illustrations in support of these views are given in the Committee Reports of the lines as taken in a graving dock, January, 1856; again in December, 1856, after being for some weeks head N.N.E. in the same graving dock: as they appeared two days after with her head in the opposite direction; and again as determined twice in January, 1857, after undergoing constant hammering in almost every part for forty-three days.]

The most instructive case of the rapid changes of magnetism in a newly-built iron ship is illustrated in the case of the ship Royal Charter, whose deviations were carefully obtained prior to leaving England in January, 1856; at Melbourne in Australia, in May, 1856; and again on her return to Liverpool in August of the same year. These changes are well exemplified by a comparison of the values of the five coefficients alluded to; the results being selected from an extended series of observations, as made with an Admiralty standard-compass specially placed in aid of the experiments.

	A	B	C	D	E
	° ′	° ′	° ′	° ′	° ′
At Liverpool in Jan. 1856, previous to going on first voyage	−0 27,	−3 48,	−19 42,	+6 59,	−0 52
At Melbourne in Australia, May, 1856 .	−1 27,	−1 11,	− 8 59,	+6 23,	−0 16
At Liverpool on return, in August, 1856	−0 3,	−1 6,	− 3 22,	+6 10,	+0 56

We see here very distinctly the permanency of the quadrantal deviation as represented principally by the coefficient D; and the gradual diminution of the subpermanent magnetism, or polar-magnet deviation, in the coefficients B and C.

Subsequent experiments in the Royal Charter indicate that the subpermanent magnetism is approximating to its original amount; but, as some alterations have been made in the ship's fitments, the comparisons are not strictly identical; they are nevertheless well worthy of attention.

	A	B	C	D	E
	° ′	° ′	° ′	° ′	° ′
Liverpool in September, 1856, after alterations	−0 19,	+1 13,	− 8 33,	+6 0,	−0 19
Liverpool in October, 1856	−0 9,	−4 55,	−14 0,	+6 41,	−0 9

Enough has now been advanced to show the valuable nature of the investigations under review, but on the subject of the changes of original magnetism in newly-launched iron ships there appears to be ample scope for further inquiry, both as to the possibility of there being some regular law of change, as also as to the probable time required for the developement of its final permanency of character. The alarming change alluded to in the Reports by the Committee of "cases in which the deviations in a steamer have changed so much as two points in the first two days at sea, while afterwards the change has not been more than 3° in as many months," is from its amount and irregularity sufficient to embarrass the most careful navigator; it is certainly to be hoped that the cases on which the statement is based are exceptional, and arising from the injudicious selection of a position for the compass (probably from close proximity to some ponderous mass, especially of vertical iron). I am certainly disposed to view them in this light from a consideration of the results obtained in the Royal Charter.

On the Errors arising from the Heeling of Iron Ships.

An important feature in the navigation of iron vessels, and one at the same time of a perplexing character to the navigator, are the changes of deviation of the compass arising from the heeling of some ships.

In wood-built vessels the errors from this cause may be considered as in general too small in amount to be appreciable in practice, unless the compass is in close proximity to the guns or other masses of iron; but in iron-built vessels the results are not unfrequently of sufficient magnitude to call forth unceasing attention and vigilance. Our information on this head is for the present very incomplete; but some few leading points can be traced, sufficient to place the seaman on his guard, and to draw attention to the general characteristics. Messrs. Rundell and Towson, the Secretary and Honorary Secretary to the Liverpool Committee, who have paid great attention to the subject, and made various experiments, are of opinion that heeling affects to the greatest extent ships that are built with their heads to the north or the south; and that the effect on the former is to draw the north end of the needle to the weather side, the deviations reaching their maxima when the ship's head is north or south (by compass), and having little or no effect when the ship's head is east or west. In ships built with their head to the south, the north end of the needle will be drawn to the lee side, the maxima and minima deviations observing also the same conditions as those just described.

I propose now to enter somewhat briefly, as I have trespassed long on your attention, on the vexed question of mechanical adjustment for compasses.

Much controversy has taken place on the propriety and indeed safety of applying an antagonistic force to neutralize that of the disturbing effects of the iron in the ship: our highest magnetic authorities differ on the point, though agreeing in the main theoretical principles as to the nature of the magnetic disturbances. The Astronomer Royal is strongly in favour of correcting the deviation of the compass by opposing forces of magnets and soft iron. Admiral FitzRoy, General Sabine, and Mr. A. Smith, sup-

ported by numerous nautical authorities, consider such corrections dangerous—except within certain limits, such as coasting navigation—and prefer a superior compass, to be considered a standard, fixed in an elevated position, convenient for careful bearings, as far removed as possible from the disturbing influence of iron, and using the binnacle compass merely as a guide to the man at the wheel.

The opponents of the system of compensation urge that it is defective in principle and dangerous in practice; defective in principle so far, that it has not stood the test of experience in distant voyages to the southern hemisphere, and dangerous inasmuch that it inspires the unskilled and unwary seaman with confidence in the stability of that which is not proved to be stable, and places in his hands a power over the action of the compass-needle, which he cannot control and of whose strength he is ignorant.

The advocates, on the other hand, contend that a fertile source of error in navigation arises from the unskilful use of the deviation tables, the corrections being frequently allowed the wrong way, by which the original error is doubled; also that the tables do not provide for changes of the ship's magnetism caused by change of geographic position, or other circumstances; and again from the want of directive power of the needles under certain conditions of large deviation due to the ship's iron, combined with the earth's directive or horizontal force being small, as in the higher latitudes; which deficiency of directive power, magnet compensation would remedy.

There are just reasons in all or many of these arguments, and the question appears more to resolve itself, as my subsequent remarks will tend to shew, into one of application under varied but certain conditions.

In the Royal Navy, as recommended by a scientific committee of truly eminent men some years since, the system of no compensation is adopted as a general principle: but a rigid adherence to prescribed rules for preserving the compass as free from error as circumstances will permit is enforced—thus no iron is permitted within 14 feet of it, if practicable; and a careful selection of site for each compass in every ship is made under proper supervision. It is accordingly found to result that the amount of deviation in the Royal Navy is in general small comparatively, and that no example of a deviation larger in amount, even in our iron ships (in England) than from 25° to 28° exists, and this only in one or two exceptional cases.

The Mercantile Marine adopts more generally the system of adjustment, and this has led to the introduction of various patented compensating plans, differing widely from the Astronomer Royal's views, based often on no theory whatever, ending frequently in failure, and thus weakening the confidence of the seaman in the compass, and leading him to consider that the magnetism of an iron ship is so capricious as to be beyond all laws and all remedy.

These remarks may not be inappropriately closed by referring to examples of the remarkable want of caution on the part of iron-ship constructors and those engaged in their equipment, evinced in the injudicious arrangements for the compasses given in the Liverpool Compass Committee's Reports. Among the instances quoted will be found the following, "The error in the first position of the binnacle was 101°. As the ship was going to the East Indies, the compass adjuster objected to compensate so large an

amount, and the binnacle was then placed three feet forward; here the error was reduced to two points. In another and much larger ship the compass in the first position of the binnacle deviated 14 points; on moving it a little further forward, the error was reduced to $2\frac{1}{2}$ points." These cases occurred when the original position was selected near the rudder-head of iron vessels, in which a strong attraction existed towards the stern.

It must be evident that under such circumstances of position, no compass, whether compensated or otherwise, can possibly act faithfully, nor can any accurate theoretical deductions be made from such examples; nor, above all, need we be surprised at the serious consequences which too frequently result from dependence being placed on these marvellous mal-arrangements. The Liverpool Compass Committee acted wisely in the promulgation of a circular calling attention to these facts, and expressing their opinion that by attention to the circumstances under which a ship is built, and care in selecting a suitable position for the binnacle, the original error of the compass may be reduced within small limits.

Any observations on the theory of a ship's magnetism would be incomplete without reference to Mr. Airy's method of compensating forces, based as it is entirely on the laws which have been referred to, that is,—

At any place the deviation of the compass in any ship, whether wood-built or iron-built, may be accurately represented as the effect of the combination of two forces, of which one alone would produce a disturbance following the law of polar-magnet deviation, and the other alone would produce a disturbance following the law of quadrantal deviation.

Consequently, at any place the deviation of the compass may be accurately corrected by well-known mechanical methods; namely, by a magnet in the athwartship direction, fixed at a distance determined by trial, for correcting the deviation when the ship's head is north or south: by a magnet in the head-and-stern direction, also at a distance determined by trial, for correcting the deviation when the ship's head is east or west; and by a mass of unmagnetized iron, at the same level as the compass, in the athwartship line or in the head-and-stern line, according to circumstances, (usually in the former,) also at a distance determined by trial, for correcting the deviation when the ship's head is N.E., S.E., S.W., or N.W.

For the same ship, the mass of unmagnetised iron, if adjusted at one port, will produce its due effect at all parts of the world, without ever requiring change or adjustment. The quadrantal deviation may thus be accurately corrected without difficulty, leaving only the polar-magnet deviation uncorrected.*

Mr. Airy's later investigations have led him to consider it desirable that the magnets should be mounted in such a manner that their distance from the compass can be delicately changed, to meet the changes of polar-magnet deviation.

We may expect at no distant period that there will be an accumulation of facts from various parts, particularly from the southern hemisphere, sufficient to prove the accuracy of Mr. Airy's views of compensation under all conditions, and whether its delicate and important manipulations can

* See *Philosophical Transactions* for 1855, Art. V., Discussion of the Observed Deviations of the Compass in several Ships, Wood-built and Iron-built, &c. with a General Table for facilitating the Examination of Compass Deviations, by G. B. Airy, Esq., Astronomer Royal.

be entrusted to all classes of navigators. On one point however mariners may be assured, that at present no other method of compensation has been brought to their notice that has been more elaborately worked out by high scientific and philosophical attainments, or that could equally stand the test of such profound mathematical analysis as has been brought to bear on the subject by the Astronomer Royal.

Captain Nolloth, R.N.—I am sure we must all feel very much obliged indeed to Mr. Evans for his lucid, admirable, Lecture.

There is one observation which I will make, and in which I think you will agree with me, that too much importance cannot be attached to navigators frequently ascertaining the whole error of their compasses, from whatever causes, by celestial observations during the voyage.

If I may hazard a remark concerning nomenclature, I would say that I do not see why we should use the term "deviation" as well as "variation," when the practical results are the same. I remember a man with whom I sailed as a passenger, and who had navigated a ship for some time, allowing the deviation the wrong way, and, when I pointed it out, telling me that he never made a mistake in allowing for the variation, but that he was puzzled now and then with the other. It may appear strange that such a person should ever have been otherwise than puzzled; but there may be others equally troubled. When told that he might consider deviation merely a second variation which had to be allowed for, the thing became clear to him.

Mr. Evans.—I think the term "deviation" is too firmly fixed to be rooted out, though it is a term of the present generation only. The last generation had not iron ships.

Captain Collinson, R.N.—You have elucidated what I may call a somewhat hazy subject, and I have listened with great satisfaction to what you have said, because you have pointed out many things which I was not acquainted with before. I would advise all navigators not to trust to any apparatus that is given them, but make positive observations. The mode of obtaining the variation of the compass is so simple, that there is no reason, if the trouble is only taken, why any vessel should be misdirected in consequence of the attraction of the iron in the ship. We know when a vessel sails from a port, as she goes down the Channel in the first meridian altitude, the captain, if he only takes the bearing of the sun at the moment when it comes upon the meridian, and enters that in the log, has a standard by which he can then adjust his compasses. The same at night with the stars.—When *any* object is on the meridian, you can get the error of the compass quite sufficient for all steering purposes. The unfortunate thing is this, that persons, after they have taken observations, do not record them. I would suggest that the captains, particularly of iron ships, when they go abroad, should be instructed to enter in the logs from time to time the errors, which they may get instantaneously by reference to the objects on the meridian; and in northern latitudes more especially by reference to the north star at night.

Mr. Evans.—I may supplement the few remarks you have made by calling attention more particularly to these charts. It has been the practice to look upon this subject as a scientific matter, not within the comprehension of ordinary navigators. I do not think that such is the case. Take the case of the variation chart—its use is very great. Independent of its being a philosophical matter, a man having his position in any part of this chart, finding the variation by his compass, and comparing it with the variation, here at once gets his error.

Chairman.—On the part of the Council of this Institution, and those Gentlemen who have listened to Mr. Evans's exposition, I beg to tender him our most sincere thanks for as interesting and valuable a paper as I think I have ever listened to in this Institution. I speak upon this subject as an inexperienced man; but it appears to me that the more the matter is ventilated the better for the commercial marine, and it will probably be a great means of saving human life.

Evening Meeting.

Monday, March 7th, 1859.

Vice-Admiral Sir THOMAS HERBERT, K.C.B., in the Chair.

The Chairman announced that 17 Members had joined the Institution between 22nd February and 7th March.

LIFE MEMBER.

Rattray, James, Vice-Admiral.

ANNUAL SUBSCRIBERS.

Adair, J. W. D. Capt. 5th Fus.
James, Henry, Col. Roy. Eng.
Margary, A. R. Major, late 54th Reg.
Swatman, Wm. Col. 3rd Ben. Eur. Fus.
Baker, W. T. Capt. 85th Lt. Inf.
Hayward, H. B. Lieut. 45th Regt.
Molesworth, M. G. Lieut. Roy. Eng.
Maguire, Rochfort, Capt. R.N.
Yonge, W. L. Capt. Roy. Art.
Yonge, H. J. Lieut. 61st Regt.
Allanway, Wm. Ens. Monmouth Mil.
Railey, Charles, Capt. R.N.
Lane, H. J. B. Capt. Coldstream Gds.
Hogarth, Joseph, Ens. 43rd Lt. Infantry.
Hume, Henry, Lt.-Col. C.B. Gren. Gds.
Armstrong, Sir Wm. Geo. Engineer to the War. Dep. for Rifled Ordnance.

NAMES of MEMBERS who paid INCREASED SUBSCRIPTIONS between 22nd February and 7th March.

Biden, John, Capt. H. A. Co^{y}.
Hamilton, W. D. Major late 13th Lt. Drs.
Briggs, John, General.
Leake, Martin, General.
Stevenson, Wm. Surg. ret. Beng. Army.
Boldero, Lonsdale, Col. unatt.
Armstrong, Sir Wm. Geo. Engineer to the War. Dep. for Rifled Ordnance.
Watson, D. H. Lieut. R.N.
Reddie, James, Esq. Admiralty.

PRESENTS.

LIBRARY.

Books.

Du Feu Grégeois, des Feux de Guerre, et des Origines de la Poudre à Canon. 1 Vol. 8vo. Paris, 1845. Planches, 1 Vol. *Presented by Colonel P. Yorke.*

J. Macintosh, Esq. Macintosh's System of National Defence; or, New Strategies in War. Pamph. 8vo. London, 1858. *Presented by the Author.*

Art Union of London. Report of the Council for the Year 1858. 1 copy; Ditto, with List of Members. 2 copies; Art Union of London Almanack, 1859. 10 copies. *Presented by the Society.*

Royal Geographical Society, Proceedings of. Vol. III. No. 1. *Presented by the Society.*

Lieut.-Col. J. J. Graham. The Art of War. 1 Vol. 8vo. London, 1858. *Presented by the Author.*

Maps—Plans.

156 Old Dutch Charts of the end of 17th Century, and one Illustrated Title-Page. *Presented by the Rev. O. S. Harrison.*

MUSEUM.

Military.

Clothing and Field Equipments of a Rifleman and Soldier of the Line; 1. Knapsack and Set of Necessaries; 2. Light Infantry Chaco complete.

Presented by the Secretary of State for War.

Miscellaneous.

Bell from the Private Chapel of the French Ship "Ville de Paris," weight about 2 cwt.; height 1 ft. 6 in., diameter 1 ft. 10 in.; Clock Face from the front of the Poop—the hand was turned by the sentinel at the expiration of each hour—taken in Lord Rodney's action with the French Fleet, 12 April, 1782.

Presented by Captain H. H. Bingham and Commander J. E. Bingham, R.N., on behalf of the family of the late Rev. Richard Bingham, B.C.L.

THE EFFECT OF THE INTRODUCTION OF RIFLED CANNON ON NAVAL ARCHITECTURE.

By Capt. FISHBOURNE, R.N.

I am to show the necessity for a change in the present practice of naval architecture, in order that the country may obtain the full benefit of Sir Wm. Armstrong's admirable invention.

I propose to give, 1st, A sketch of the advantages it affords; more would not be proper. 2nd, A sketch of the practice of naval architecture that it is requisite to change.

The great results obtained from rifle muskets, both as to range and precision, made the adaptation of breech-loading cannon a necessity that could not long remain unsatisfied.

It seems a guarantee for the continuance of our prestige, that no sooner is there a want really felt than genius and skill start up to afford an ample supply.

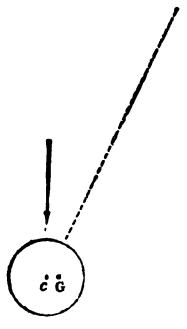
The principle on which Armstrong's gun is constructed is so correct, and the details of its carriage-slide and missiles so simple and complete, that it will be the work of but a short time to satisfy the most incredulous as to their great value.

The precision of fire attainable by it is alleged by competent authority to be fifty times greater than that obtained with the ordinary service-gun throwing solid shot of equal weight, each at a distance of 1,000 yards; indeed it is six times more accurate at 3,000 yards than the ordinary smooth-bore gun at 1,000 yards.

To arrive at the accuracy of fire, range, and penetration, realised, there have been used, 1st, Elongated shot, by which, while equal momentum has been preserved, a very great reduction of the area of resistance has been effected. 2nd. By the rifle principle, rotatory motion is communicated to the shot, by which, together with the right adjustment of the centre of

gravity, and of the form of its anterior surface, the longer axis during the flight is preserved parallel to the axis of the gun, and great accuracy attained.

Fig. 1.



Hitherto, owing to the extreme difficulty, amounting almost to an impossibility, of casting homogeneous spherical shot, the centre of gravity was never found in the centre of the sphere; hence the shot in their flight were diverted from their proper path, by which great disparities in range and deviation in direction were occasioned.

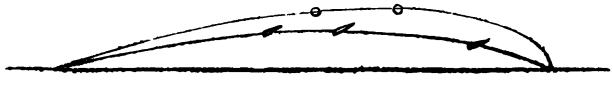
Suppose fig. 1 to represent a spherical shot, *c* its centre, *g* its centre of gravity; when it is projected by the explosion of the charge, owing to the greater amount of surface being to the left of the centre of gravity, the shot will rotate round this centre from left to right: let the arrow represent the resistance of the air to the shot in its trajectory—the direction of which, owing to the rotation described, is opposed to that of the left side of the shot, while that of the right side coincides with it; the result is, that a diminished pressure obtains on the right side, and an increased pressure on the left side; consequently, the shot will be deflected to the right into the line of least resistance;* when the centre of gravity is *below*, the deflection is downwards, by which the range is shortened, and, though the absence of homogeneity is directly a source of great error, in practice it produces indirectly still greater. Thus the captain of the gun, observing that a shot falls either to the right or short, attributing this to misdirection of the gun, or to insufficient elevation, rather than the true cause—that assigned, he gives more elevation, or points his gun to the left of the object; of course under these circumstances, if the centre of gravity of subsequent shot be *not* similarly situated, and the chances are against its being so, it will fall still more wide of the mark.

By using a ball which fills the cylinder of the gun much cause of error is avoided.

The ordinary spherical shot not filling the cylinder, in its motion it strikes one part or the other uncertainly, and becomes proportionably uncertain both in its direction and range.

Everything which contributes to remove the causes of deviation tends to increase range, and increase of range tends to precision of fire; as, under such circumstances, less elevation is required for a given distance, the shot travels nearer the earth, and will strike objects of a moderate height that intervene—as the elongated shot compared with the round shot in fig. 2.

Fig. 2.



Greater safety.—The superior principle upon which this gun is con-

* See Appendix to Col. Lane Fox's Paper on the Improvement of the Rifle, vol. II. p. 489 of this Journal.

structed is a greater guarantee against its bursting; and it cannot reasonably be doubted but that loading at the breech will be attended with less danger from accidental explosion of charges; also, the danger to men (increased by the introduction of rifles) while loading at the muzzle will be avoided, and the occasional danger from fire left within the gun is disposed of by the use of a moist sponge.

Greater rapidity of fire—by which I mean the delivery of *effective* fire.—I use the expression *effective* advisedly, as a comparison as to the rapidity of firing without aiming at an object has been sometimes absurdly instituted. Armstrong contemplates firing four times in a minute.

The facilities for delivering a rapid fire from this gun are great, because the distance which the cartridge and shot have to travel is much less—because the position of the loader is more advantageous for effecting his object, which, in comparison of muzzle-loading, is enhanced in proportion to the weight of the shot used; and, should an accident occur to the rammer—not uncommon to the long handles of those used for smooth-bore guns—this can be loaded by hand.

The gun has not to be run up each time, nor does it require to be pointed each time, unless the object or battery be in motion; even then the facilities for pointing are greater than in the ordinary guns.

The power of delivering a rapid fire may not with propriety be estimated for a limited period, but rather be connected with the adaptation for comparatively continuous fire.

As the charges are considerably less than half those ordinarily used, and, as the moist sponging and the rush of cool air from the open breech tend to keep the gun cool, the fire could be continued very much longer than from the ordinary guns.

Economy.—In estimating this, owing to its increased efficiency, it would be impossible to set off the cost of gun against gun, but rather against the cost of the number to which, owing to greater range, precision, and power of dispersion, it in effect is equal to.

Convenience.—This hardly expresses the increased value of this gun due to its greatly reduced weight; owing to which it admits of easy transport—field-pieces and guns for battering purposes being much less than half the weight of those ordinarily used.

Great as are the advantages stated, it possesses greater for ships' batteries, for reasons which I purpose giving hereafter, proceeding first to give a practical illustration of the comparative advantages before alluded to.

Lieutenant Dahlgren (United States Navy) mentions that at 260 yards each of ten shot fired from a 32-pounder were included in four feet square of the screen aimed at, while of ten shot fired from the same gun at a screen 40 feet long by 20 feet high, and distant 1,300 yards, only three struck: that is, at five times the distance, though the target was increased fifty times, only one-third of the shot fired hit it. One hundred shot fired from Armstrong's gun at a target nine foot square, and distant 1,500 yards, struck nearly every time, knocking it down several times; after which it was fired at, still on the ground, and was hit several times; and yet all this occupied but two and a quarter hours, and the temperature of the gun at the termination was only 150°.

Although this illustration tells very much in favour of the latter gun, such estimates, founded upon mere "hits" of large targets, by no means mark its immense superiority; for, as the value of guns is in proportion to their power of throwing shot into embrasures, of hitting a narrow and definite line for breaching purposes, or of throwing shot into ships' ports, or of hitting them "between wind and water," so must estimates of their comparative value be drawn from the precision with which they strike *small* objects. The additional value of those described for ships of war arises from the fact of their being so much lighter, and from the small amount of their recoil *(practically none)*, owing to which they will not require ships of such great breadth. This involves very great general naval efficiency and economy.

The small external diameter, particularly at the chase, will admit of smaller ports; no inconsiderable advantage should ships' sides be covered with plate-iron.

It is not my purpose to state all the advantages to be derived from this admirable invention; sufficient has been said to show the necessity for its introduction, and that doing so at an early period will cost the country much less. The efficiency of the navy also will be increased in proportion to the promptness with which it is applied, provided its value is not rendered nugatory by an absence of adaptation in the forms of the ships.

The wonderful success described has been obtained by an accuracy of detail that some, who pique themselves upon being practical, I say not how correctly, would, *à priori*, have characterised as theoretic and crochety, but which nevertheless has proved to be eminently practical.

If the practice of naval architecture is to be progressive, if, in fact, we are to elevate it to the rank of a science, which it is now only in part, whatever professional architects may say to the contrary, we must follow out our observations and experiments with similar accuracy of detail.

The present practice, for war purposes, bears the relation to what it ought to be, that the service ordnance does to Armstrong's guns.

Not that ships may be designed that shall sail or steam fifty times faster than at present; but they may be made some indefinitely large quantity more valuable for war purposes—it may be, in some cases, fifty times more so, and at less cost.

It has been said that the introduction of steam and progress of scientific discovery necessarily entailed rapid and extensive changes—say, rather that this progress has found us pursuing an unscientific course. Science moves with measured strides, like "coming events casting their shadows before;" her every step is the subject of law, and none can follow, however distant, but must be so far in harmony with her designs as not to need at any time to have recourse to more rapid or to radical changes. Thus, the lengthening of new ships' bows ought not to have been required, as the long bow should have formed part of the original design, its value having been proved full fifteen years previously; indeed, the longest adopted are still shorter than that which science would dictate.

We condemned a whole fleet of ships; and yet, whatever were their defects of size, for correctness of design, and for adaptation to the purpose for which they were intended, as a whole they are unsurpassed, nay, unequalled by their successors. Let me not be misunderstood. It is

true that the latter were larger and, in the ordinary sense of the term, finer ships; yet, had we adhered to the principles contained in these earlier forms, we should have more efficient ships than we now possess.

Again, when steam-power was introduced the authorities had embarked at a cost of three millions in building another fleet* of ships of great proportionate breadth, and of a general form that was opposed not only to the authority of the best standard treatises on the subject, but to the accumulated experience of ages; nor was it the introduction of steam that opened our eyes to the fact that in building such vessels we were steering vastly wide of the track which science would have dictated—that fact was made patent by the sailing squadrons of 1846 and 1847, which led to the abandonment of the extreme peculiarities of the forms alluded to. No doubt, however, the expensiveness of steam as a motor forced upon reluctant minds the fact, that ships of greater proportionate length than had ever been adopted were more easily driven, whether by sails or steam. Long before that, however, merchant sailing-vessels of this and other countries had yielded abundant proofs to that effect. Why we should not have drawn inspiration from such sources it is difficult to understand.

But, while the discovery that we were far wide of the proper track led to a decided improvement in our practice, it did not lead us to the re-adoption of those sounder principles of design which characterised some of the older models, both French and English.

This is attributable in some respects to the same cause as that which led to the adoption of great proportionate breadth and rising floors, viz. the undue importance attached to great speed, and the misapprehension how that quality might best be obtained. This had the effect, not yet wholly got rid of, of obscuring what one might have supposed to have been very obvious, viz. the fact that it is impossible to exaggerate one quality in a ship without proportionally diminishing one or more others.

It is too much the habit of professional men to assume that laymen cannot understand these things; they, therefore, deliver their opinions *ex cathedra*, and afford us no proof: on the contrary, I profess to be a sailor, and have long acted upon the principle, that, if I could not explain to an intelligent mind or indeed educate an uninstructed one up to a comprehension of any point connected with my profession, the fault was in myself. Now what we require is, that naval architects will cease to obstruct those who are searching for truth, acknowledge—what all are beginning to discover—that there is an amazing amount of ignorance on the subject of naval architecture even amongst those who have studied the subject most, and join us in our search. Enough of time and money has been wasted in experimenting without system, and too often in violation of principles; no plans should be accepted without proofs of their correctness, or without being tested by the application of carefully arranged statistics.

As our information in some respects is only comparative, we may thus inquire what the fact is as respects some of our modern ships of war. If there is an adherence to principle in their designs, we shall be able to trace a consistency throughout, that is, a definite relation in the proportions of one dimension to another, as length to breadth, depth to breadth, and in

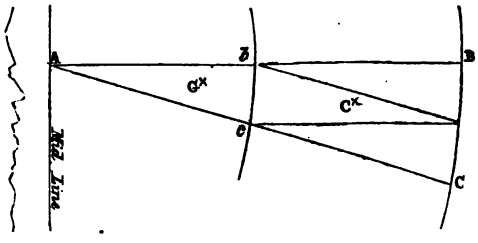
* This will account for the great number of ships of the line which we possess, and which it is proposed should be allowed to rot.

screw vessels between the area of screw and its depth of immersion, and the area of greatest section, or only such a departure as was indispensable, and as did not mar the design.

There are two things which have always been held as ruling the proportion of breadth to be given to vessels of war—a sufficiency to obtain stability and a good platform for guns. The precise quantity necessary has been for some time a vexed question, therefore an opinion from any one cannot be deemed sufficient. Nevertheless, what is not a proper quantity may be arrived at, and much fairly inferred from that.

Ceteris paribus, stability increases as the cube of the breadth, the moment of sail or power that produces inclination not increasing in so rapid a ratio; consequently the larger the ship the less is the proportion of breadth required to produce a sufficient amount of stability.*

Fig. 3.



When a vessel inclines she immerses a prism on one side and emerges an equal one on the other; by the volume of these, and by the distance of their centres of gravity from each other, is a vessel's stability compared with that of another. Suppose fig. 3 to represent one of these prisms for each of two vessels, one double the breadth of the other; from this it will appear that A *b c* is only one quarter that of A B C, and G is only half the distance from A that C is, therefore the effect of the larger prism is equal to $4 \times 2 = 8$; in other words the stability of a vessel of double the breadth is eight times that of the smaller; but 8 is the cube of 2.

The following dimensions—

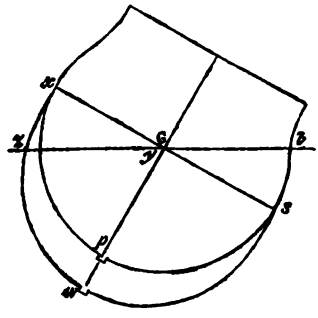
	Length. feet.	Breadth. feet. in.	Ratio of Length to Breadth. feet. in.
Marlborough ..	245	61	4 0
Renown	245	55·6	4 $\frac{32}{55}$
Racoon	200	40	5 0

show that the smaller vessels have the least proportion of breadth, which is the reverse of what adherence to the law above described would require. Nor can it be said that this arose from the necessity for a wider battery in the larger vessel, for the "Racoon" carries guns on her broadside of equal length and calibre with those carried by the "Marlborough."

There is another dimension, viz., the depth, which exercises an important influence on the properties of ships; this, also, has been treated as if there was not a proportion of it to breadth that was more correct than any other.

* By stability here, I mean the power to resist inclination from the pressure of the sails, a quality which conduces under certain circumstances to fast sailing.

Fig. 4.



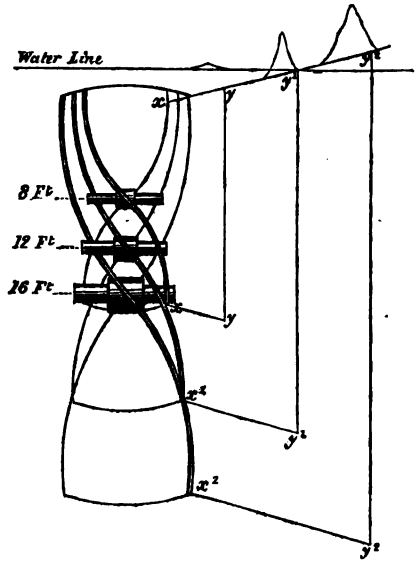
If we suppose Fig. 4 to represent the cross section of a vessel, which may be taken as far as the principle involved is concerned to represent all her sections, and she to be inclined to the angle $x\,y\,z$, this will be as if the emerged solid $x\,y\,z$ were carried over to $y\,b\,s$, and the power requisite to effect it will be great as the volume of these solids is great in proportion to the whole volume of the ship. If we suppose the ship's immersed depth to be only from y to p, then the volume of these solids will be greater in proportion to the volume of the ship than if her depth be increased to w; that is, suppose it possible while the vessel is inclined that an increased volume were given between the line $x\,p\,s$ and $x\,w\,s$; the volume of the solids $x\,y\,z$ and $y\,b\,s$ not being increased, the effect would be to float the keel up and diminish the stability. This is what takes place when a vessel is made deeper in proportion to her breadth, yet, strange to say, the smaller vessels are those which are chosen to be made deeper, and so their proportionate stabilities are further reduced, though already small from their limited size, and less also, because they have received a less proportion of breadth to length; thus:—

	Mean draught. feet. in.		Half breadth. feet. in.		Difference. feet. in.
Marlborough . .	25 0	to	30 6	=	5 0
Renown	24 0	to	27 6	=	3 6
Racoon	18 5	to	20 0	=	1 7

Now, if the smaller ships have sufficient breadth of beam for stability and for a good battery, then the larger ships must have too much; that they have will further appear from other considerations, for it cannot be said that the "Renown," because of having a deck more than the "Racoon," requires fifteen feet more breadth. Again, in order to obtain satisfactory results with a screw, that is, speed economically, it is necessary that the area of the screw shall bear a certain relation to the area of the greatest section, and that the screw shall be sufficiently immersed to obtain sufficient resistance to its thrust. From the following diagram it will be clear that the greater the diameter of the screw, the greater is the distance it should be immersed to obtain proportionate effect.

Suppose fig. 5 to represent the forces given off by screws supposed proportionate to their diameter, for it would be impossible to apply a large power to a screw of small diameter, then the lines $x\,y$, $x^1\,y^1$, and $x^2\,y^2$ may be taken to represent the direction and force of the thrust from each of 8, 12, and 16-foot screws respectively; from this it is clear that, if the larger screws are not more immersed than the smaller in proportion to their size, that part of their thrust will be lost in throwing up water at y^1 and y^2, instead of propelling the ship; this view of the case is

Fig. 5.



confirmed by experience. This points to another ground of objection to giving great proportionate breadth to depth.

The area of greatest midship section, representing the principal element in resistance, will be the same whether the breadth and depth are—

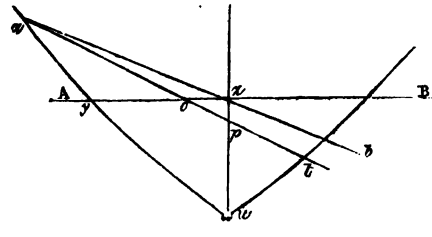
Breadth.	Depth.	
as 44	× 18·2	= 800·8
or 40	× 20·0	= 800

But in the one case the screw could be immersed two feet more, and its effective results proportionally increased. In illustration of this fact it may be stated, that, if the "Diadem" had been two feet deeper, though her displacement were also in that proportion increased, she would have been a faster, as she certainly would have been in every other respect a more efficient, ship.

It has been stated that Sir William Symonds gave great beam to our ships, and that his successors did well to continue it; this is not true in fact, and, nominally, only true of the three-deckers, which, being larger, have equal breadth no doubt, but less in proportion to their length; still I assert that great beam is an unmixed evil.

The ships in question were uneasy, and it was assumed that, owing to the form of the solids immersed and emerged as they rolled, their centres of gravity rose and fell; that this was the sole cause of such motions; and that if their sides near the load water-line had been straight, or equally curved, this motion would not have taken place. This is a mistake, and one that has injuriously affected nearly all our modern ships. The defect may arise from a different cause.

Fig. 6.*



1st. I may explain the effect of the inequalities alluded to:—

Suppose A B to represent the surface of the sea, and *x y u t r* the outlines of a section of a vessel floating upright; for convenience of illustration, suppose the sea line moved on this section from A B to *a b;* this supposes the vessel to have moved round *z* as the centre of her longitudinal axis, which cannot be, as the solids, emerged and

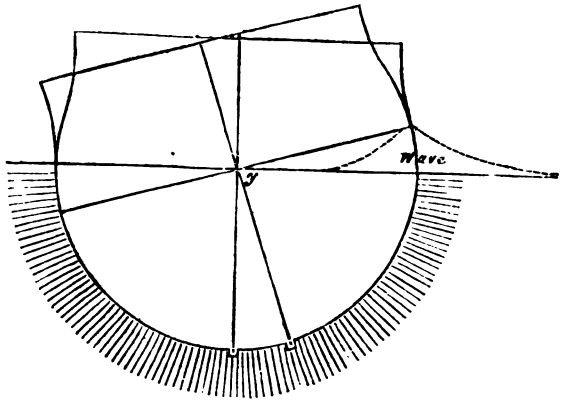
* This figure is exaggerated for better illustrating the point in view.

immersed, must eventually, though not instantly, become equal, which is contrary to the supposition; consequently the ship must rotate round some point, suppose *o*, at the intersection of the two planes that form two equal solids of emersion and immersion, in which case *z* and the centre of gravity equally will have been raised a perpendicular height equal to *z p*. In proportion as ships have this form near the load water-line—and all have it more or less at their extremities—will their centres of gravity be subject to a similar motion—the less, however, the better.

But a similar motion may arise from a form, the sides of which are "either perpendicular or equally curved" immediately above and below the load water-line.

The bottom of a ship is subject when afloat to an infinite number of pressures which act at points perpendicular to the surface with which they are in contact, and sustain her by their joint action; and, though there is ordinarily easy play amongst the particles through which these pressures proceed, yet, when motion round a longitudinal axis is communicated rapidly to such a body, the water resists proportionally as if it were rigid, and the effect is somewhat similar to that which takes place when a body is rolled upon a rigid plane surface; this will take place whatever may be the force which communicates the motion, so that it be rapid in its action. If the force be applied at one side the body will rotate round some point on the other side of the centre of gravity from that on which the force is acting, and more distant as the form of the body is less circular, and less deep than wide. Suppose the inclining forces to be waves, which are the forces we have in most cases, these to be of equal dimensions, and to arrive at the side each of figs. 7 and 8. Suppose *y* and y^1 to be the position of

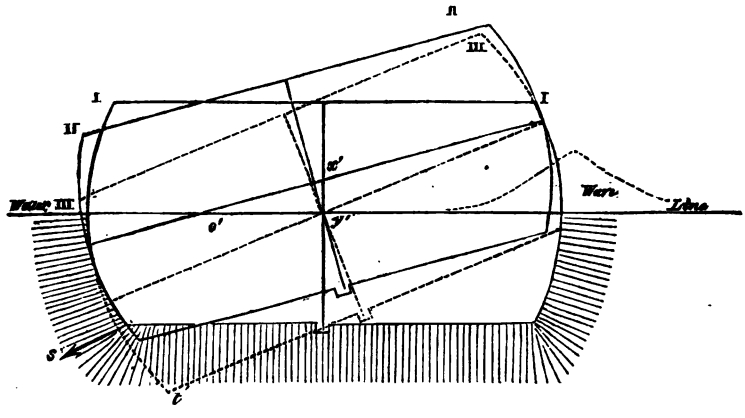
Fig. 7.



their centres of gravity; from a bare inspection of fig. 8 it will be evident that the common idea that when a vessel inclines she revolves round her centre of gravity, cannot possibly hold, even approximately, in vessels of such a form; for if, on the wave arriving at the side of fig. 8, we suppose

her to revolve round y^2, we must suppose a rapid and deeper immersion of one side of her bottom, from s^1 to t^1 against the pressures already on it, when she would assume the position represented by the dotted lines, which

Fig. 8.



is obviously impossible. What takes place is, that the buoyancy added lifts the vessel high in proportion to its amount and the length of lever through which it acts, as compared with the resistance on the opposite side offered to greater immersion—the position the vessel would assume would be rather that of II II than the dotted figure III III.

It is equally obvious that, the wider the vessel and the less the depth in proportion, the greater will be the amount of buoyancy added during the passage of a wave across the centre line of the vessel; the greater the lever to lift her, and the higher will her centre of gravity be raised; the vessel will in reality rotate round some point, say o, and her centre of gravity will rise from y' to x; when the wave passes the middle line of the vessel an opposite action will be set up, equally great in proportion to the breadth, but still greater and more rapid from the acceleration caused by the fall of the centre of gravity from the greater height, which will occasion the centre of gravity to rise proportionally higher on the succeeding roll. These motions will be violent and something like that of a wheel going over a stone.

In vessels of the form of fig. 7 there is little of this motion, arising from the fact that the points of pressure are all equidistant from the centre, in consequence of which there never arises a sudden demand for a deeper immersion of any part than that which ordinarily obtains.

The motions alluded to above will take place irrespective of the position of the centre of gravity in the vertical plane; though its position might aggravate the evils described, no arrangement of weights could mitigate the evils of such bad forms as that of fig. 8.

The above is fully confirmed by experience, as may be perceived by

hat the widest ships with
ost uneasy—that is, roll

Diff. of 4 and 5 Col.	Character.
ft. in.	
4 8	Uneasy.
1 6	Very easy.
2 2	Easy.
5 8	*Very uneasy.*
2 4	Easy.
3 11	Uneasy.
1 9	Very easy.
4 6	Very uneasy.
5 0	
4 0	
1 6	Very easy.

and shew the recognition

Diff. of 4 and 5 Col.	Character.
ft. in.	
0 11	Very easy.
1 8	—
2 3	—

and somewhat less to the
me and under the same
ht times and 27° one way,

' Queen " was observed to
me and under the same
five times and 13° and 5°;
er first lower deck ports
commencing to shut her
her than her ports.
roll four times while the

due to the inequalities of
been asserted, for the

which are dangerous only in
ling ships, simply so, and screw
proportionably deeper.

"Agamemnon," "Hecate," and the "Queen," very nearly so, have their sides perpendicular at that part; indeed, the "Queen" was originally laid down as a "Trafalgar."

If, on the supposition that moving the centre of gravity would mitigate the evil of quick rolling, weights were raised in the "Queen," Albion," or "Superb," as a consequence they would roll deeper, but that fault is already too great; and if weights were lowered quicker rolling would ensue, but this is already too quick.

It must be observed also, contrary to what might have been expected from considering the effect of weights alone, notwithstanding their third deck, which, with its guns, must have amounted to 350 tons, situated say 25 feet above the centre of gravity, the "Queen" and "St. Vincent" were easier, and rolled less deep than vessels of their own type and nearly similar dimensions, viz. the "Albion" and "Rodney" respectively, principally because of their greater immersion, the "Queen" partly because of her fuller body below. This view is endorsed by the reports of their Captains. Captain Lockyer wrote: "'Albion' rolls quicker perhaps for want of ballast, and her rolling has *increased* since the ballast and shot have been removed, and the ship *lighter from want of water and provisions.*" And Captain Corry wrote of the "Superb:" "her rolling is quick, and in proportion to 'Canopus' as 3 to 2, which in light airs, with any swell whatever, renders her very unsteady, and makes it *difficult to take accurate aim with her guns.*"

More recently the "Agamemnon," when she had the Atlantic cable on board, with a swell abeam, and very little wind, rolled 20° to starboard, and 12 to port in 9·4 seconds. It must be added, that this was stated to have been due to the fact of the cable having been stowed too low; a sufficient contradiction to this however is, that the obvious consequence of raising the weight would have been to have increased the extent of the roll, just in proportion as it reduced the rapidity; on the subsequent cruise, but during bad weather, the vessel having been lightened 5 inches, and having had 200 tons of cable placed on the upper deck, lurched to upwards of 40°, and completed her roll in 10·3 seconds. The American frigate "Niagara," on the first occasion, was said "scarcely to roll at all," while the "Agamemnon" was rolling both deeper and faster, and yet she had the greater portion of her moiety of the cable stowed very high; consequently, if the effects described were due to the position of the weight alone, she would have rolled deeper but not so fast. This ship, however, as she discharged the cable rolled more, and considerably by the time she arrived near Newfoundland, when she had discharged the greater part of the cable. Admitting some small portion of the difference between the rolling motions of these two ships to have been due to the difference in their dimensions, yet the principal cause was the large mean breadth of the "Agamemnon," and the comparatively small mean breadth of the "Niagara," as compared with their respective draughts of water, which in the first cruise was equal; the difference of mean breadth being due to their difference of form. If dimensions necessarily make a vessel easier, it may be asked why the "Albion" was so much less so than the "Canopus." The owner of a yacht, and one of the best informed on the subject that I have met, says, "The rolling of my vessel has been strikingly

diminished by lengthening her by the bow 8 feet," which he justly observed must have been in a great measure because her mean breadth was reduced.

It cannot be, as has been said, that the uneasiness of H.M.S. Agamemnon was due to the abstract fact of her being deep, for it is no uncommon thing for merchant ships to be much more so; thus, for instance, a ship of Mr. Green's brought a heavy cargo from Calcutta not long since, and was very easy.

The following dimensions will put this in a clearer light :—

	Length between Perpendiculars.	Half-breadth.	Mean Draught.
	feet.	ft. in.	ft. in.
H.M.S. Agamemnon . .	234	27 6	26 0
Mr. Green's Agamemnon .	244	18 0	19 6
White Star	285	22 6	24 4½

That is, the merchant vessels "Agamemnon" and "White Star" were proportionally deeper, the first by 3 feet, the second by 3 feet 4, than the man-of-war, which was said to have been under extraordinary circumstances.*

Easiness is so important, that its value should be further illustrated and enforced.

It is stated by Sir Howard Douglas that a second may elapse between the time of pulling the trigger and the time the shot leaves the muzzle of the gun. The arcs of roll of the "Queen" and "St. Vincent" being respectively 3° and 1½° in a second, we have but to suppose equally expert gunners, each to aim at the water line of the other, and each to fire with a rising motion, the ships being 30 feet high and 400 yards apart, and the second alluded to to elapse, the result would be, assuming that there is no other cause of deviation, that the "Queen's" fire would pass over the hull of the "St. Vincent," while every shot of the "St. Vincent" would hit the hull of the "Queen," and yet the "Albion," "Superb," and "Vanguard," rolled three times as fast as the "Queen;" how then could it be expected otherwise than that sister ships to these, as the "Colossus," "Exmouth," and others, should be otherwise than failures.

There is no reason to doubt but that the motions of the "Marlborough,"

* It has been objected that in a pamphlet which I printed last year I understated the draught of water of the Agamemnon, and to that extent undervalued her as compared with the "Napoleon;" this implies that the defects of the former were confined to deficient draught, and that those who objected to my view would have been content had hers been equal to that of the "Napoleon." Now I, on the contrary, contend that her form also is defective in principle, just where the French have borrowed from us, viz., in giving undue breadth; and while, as I believe, she is superior to the Agamemnon, her breadth is still too great by several feet for her depth.

I was contending for a principle, and took the most correct information at my disposal; the incorrectness of this however, even if it had been greater, would not have affected the *principle*, and in the case in point the only thing that was grounded on the fact was the propriety of inquiry before any ships similar should be built, a course not without value whatever the facts may have been.

I could have no wish to misrepresent, inasmuch as the fact, whatever it may be, "cuts both ways;" thus in the same pamphlet I argued that it was not an undue weight of cable that caused her to roll so deep and so rapidly: this argument gains considerable force by the admission that she was only 2 feet or 2 feet 6 inches more than her proper draught, instead of 4 feet, more or less a few inches.

though less than those just named, would be faster than those of such ships as the "St. Vincent" or "Trafalgar," as from the table the difference between her half-breadth and her mean draught is as 5 to 1·6, and 2·2 respectively.

As the deviation increases with the range, it were absurd to expect efficiency from ships that are so uneasy under not unusual conditions of weather; and if unfitted for smooth-bore guns, how much more unsuited to rifle guns, when, in addition to their great range, their shot take longer before they leave the gun.

The following is a more pointed illustration of the necessity for steady platforms. The "Hecate" and "Antelope" were anchored off the coast of Africa under very similar conditions; that is to say, they had about an equal proportion of provisions and water, &c. on board; the former was rolling 11° each way and eight times in a minute—her commander states that her guns could not have been cast adrift and worked without danger.

He visited the "Antelope" officially, and found she was rolling but 5° each way, and about four times in a minute; her guns were cast adrift, exercised, and satisfactorily pointed at a target. The commanders of both vessels agreed that the "Antelope" could have destroyed the "Hecate" with ease, as the latter at a moderate distance could not have hit the former much oftener perhaps than once in fifty times.

In this case we have a vessel carrying only three guns, admitted to be superior to one a sixth larger, and carrying six guns.

It is evident that had the "Hecate" had 100 guns, and had rolled with equal rapidity, supposing only that the "Antelope" should have, as in the case in question she had, greater speed, her 100 guns would not have saved her from the fate predicted of the 6-gun "Hecate;" and if this case can occur with smooth-bore and comparatively short-range guns, how much more certainly would it do so were the "Antelope's" guns accurate and long-ranging rifles.

Rapid as was the motion of the "Hecate," it was less than that of H.M.S. "Agamemnon" under favourable circumstances of weather, and only one-fifth that of the "Albion;" still it was at the rate of 3° in a second.

The form of the "Hecate" and "Antelope" near the load-waterline was similar, so far as having equally vertical sides; consequently, the difference in their motions could not have been due to any inequality there.

I stated in a pamphlet last year that the "Diadem" would roll considerably; it is now reported that she and the "Cæsar," 90, were lying at Greytown together, and that the former rolled twenty-five times, while the latter rolled only fifteen times. If these ships were under equal conditions as to the swell, and equal as to the proportion of coals, water, and provisions they had on board, then are we receding in our practice of shipbuilding, as the "Cæsar" is a much older ship, and a much shorter ship; whatever was the cause of the difference, it should be inquired into, and if possible removed, if not avoided, in any future ship.

In a paper of this sort, it were impossible to do more than clearly recapitulate the principles already enunciated.

The depth of water in which any projected ship is to be navigated should be taken as the limiting principle of the design; from that the

immersed depth should be determined, and the vessel designed on that as a basis, and upon definite principles.

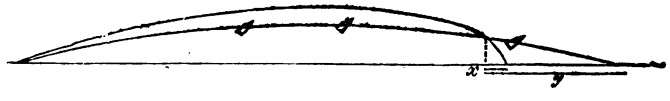
If a maximum fitness as a floating battery or effective sea-going ship, there must be a definite ratio preserved between the breadth and the mean immersed depth. If the horse-power is to be kept within satisfactory limits and a sufficient immersion obtained for an effective screw, the half-breadth should not exceed the mean immersed depth, and the centre of gravity should be kept proportionably low; if a maximum result as to efficiency and economy, so far as form will effect it, a fine bow and suitable midship section should be added—slightly convex at the load-water-line is the best form.

One or two important points bearing rather upon the practice than the principles of naval architecture that should be adverted to are—

1st. The excessively destructive nature of Armstrong's shells, the certainty of bursting them, and at pleasure, and the very much greater degree of accuracy with which they can be thrown, warrant the conclusion that it would be a useless expenditure of men and guns to crowd so many as is now done in ships of the line, since small but suitable ships mounting Armstrong's guns could destroy them without much risk to themselves, if the larger vessels mount only smooth-bore guns and without undue risk if they mount rifle guns. Lofty ships will also be more open to objection as rifle guns are introduced.

The deviation of rifled shot from the vertical plane is so small that, from a steady platform, throwing a shot within the breadth of a vessel of the smallest dimensions, even at 3,000 yards, is a matter of certainty; consequently, the only hope of escape from such would be by avoiding to build ships high. The difference arising from the use of rifles compared with smooth-bore guns may be seen from a comparison of the form of their respective trajectories, which are approximately as

Fig. 9.



On the assumption that these represent approximately the trajectories of shot from the respective kinds of ordnance referred to, it appears that unless the round shot falls within very narrow limits—that of the short line x, fig. 9—it does not take effect, while the rifle admits of considerable error in distance, equal to the line y, fig. 9. The great importance of this difference in ship practice can only be realised by considering, first, that the round shot is subject to much greater error in range than is the oblong shot; and, secondly, the fact that, ships being generally in motion, there is always more or less of uncertainty in the distance of the objects fired at.

No steam fleet can be complete in its equipments without its fleet of colliers, the speed of which will generally regulate that of the steamers, otherwise they will require armed ships to convoy them. The most appropriate use of many of our old sailing vessels would be that of making them colliers, rather than selling them, or allowing them to rot. Give

them Armstrong's guns on their main decks, and small auxiliary power to use in calms, they would double the effectiveness of the steamships by the supplies of power they would carry, and would themselves form no inconsiderable additional force. From their greater steadiness, and the destructive character of Armstrong's shells, they would handle a "Grande Bretagne" or "Duke of Wellington" very severely before they could close to such a limited distance that the number of guns in the latter should overbear the greater precision of the former. The number and size of colliers must be proportional to the aggregate horse-power of the steam-fleet, which shows the necessity of building vessels that will realise the necessary speed with the least amount of horse-power; not directly on the score of economy, though that would be no inconsiderable advantage, but for purposes of efficiency.* From an absence of proper adaptation, the "Diadem," of 82 guns, with 800 horse power, realises little more speed than the "Renown," of 91 guns, with only a similar amount of horse-power, and doubtless not consuming more coal, though the area of their respective midship sections are as about 10 to 13.

Yet, with or without the addition of the auxiliary force above alluded to, we may affirm that till our naval history, which now details almost uninterrupted triumphs, is substituted by records of disasters, England will not have anything to fear from a single-handed foe.† From a combination in the early stages of a war she might apprehend injury; then only because of wanting men, or because the rear of her fleets might not be open to obtain supplies of coals. Were Armstrong's guns and fittings adapted throughout our Service, it would afford us a solution of this our greatest difficulty. His 70-pounders can be worked by five men as easily as the smooth-bore 68-pounders by seventeen; while in certain conditions of the sea the former could be used with effect, though the latter could not be "cast adrift" with safety. Nor is it a small advantage, physically and morally, that these five men are relieved from the labour and distraction of running the guns in and out. Even courage would evaporate with the intense exertion of working large guns, and carefulness in pointing would be at an end. In fact, the weight of men and guns moved in this operation every round shifts the centre of gravity of the ship from 12 to 18 inches, which generates oscillations in the smoothest water fatal to that accuracy which is of increasing importance.

Armstrong's gun, on the other hand, working on a pivot—the recoil being provided for by a beautiful arrangement—the hustle and bustle of tackles and the exhaustion alluded to is provided against.

* It has been well said by an American naval officer that *great* steam-power is of most value for running away. It certainly will not in action prove of the high value which has been given it, nor will the result justify the great sacrifices which have been made to obtain it. When such ships have used much of their coals, they roll very much, which will in action place them very much in the power of auxiliary-powered ships, if not also in those of sailing ships. If large powered steamships go into action they must come down to the terms of their opponents; and if the latter are also to make good use of their time, the speed of the former may not suffice to take them out of action in time.

† We possess a very much larger number of sailing ships than any other power; and the necessity for an auxiliary force, such as I have described, shows that these vessels should all be counted as part of our effective force, provided only that men can be obtained for them.

Again, the demoralisation which was found during the war to arise from wounds and death occurring on crowded decks will be entirely avoided by small crews.

Effective sea-going ships with iron-plated sides can be obtained only by building them for the purpose, and then narrow and deep. Plated ships we shall come to, though it might be that neither the plates nor the ships' frames should resist rifle 70-pounders, or heavier shot, at comparatively short distances; for at such distances plating becomes of much less value, as the accuracy attainable with Armstrong's guns will admit of the shot and shell being put through the portholes—the proper way, indeed, to assail, as the enemy's guns and men are collected there; but it may be that less heavy plating than that proposed may be used with advantage.

Such adaptations as the "Gemappes" can be but bad make-shifts, justifiable only because of having ships that ought to be utilized; to build anything like her or still less like any of our wide ships would be unpardonable, as this were to throw away the principal advantages offered by this gun.

The crew that would suffice for thirty-six of Armstrong's guns would be wholly inadequate for the large masts of such vessels as the "Gemappes;" or suppose ninety of his 70-pounders placed in the "Renown" in lieu of her hollow-shot 68-pounders, it would be absurd to draw any comparison between the two armaments, the former is so superior in range, in accuracy, in lightness, in the certainty of the action of the shells, in the security in a seaway, in the limited amount of powder they require, in dispensing with tackles, and, notwithstanding the assertions to the contrary, in the destructive character of his shells. Other shells, owing to the circumstance of their centre of gravity being on one side, are subject to great deviation, and they are uncertain in bursting; many fell into the ditch at Sevastopol unexploded; Armstrong's, on the contrary, always explode. And, though the hole made by their entrance is very small, this is a cause of their greater efficacy, making a small hole, and entering the wood rapidly, the hole closes after them, so that when the bursting powder, of which there is a larger quantity, explodes, its effect is greatly intensified in consequence of its being so confined, vastly more than takes place where the hole is larger, as part of the explosive force passes away through it. Consequently, were the "Renown" thus armed, she would have a far more effective armament; and, were it not for her large masts and sails, might have her crew applied to the manning of two other 90-gun ships; reduce her breadth, and her masts and engines may be reduced in the same proportion. This also would be altering in a direction to obtain a steady platform, and, great as these advantages would be in effectiveness, and in economy, they would be nothing in comparison of the priceless value of the men made available for manning other ships.

I fully believe that a saving on one such ship, if it were deemed expedient to place so many as 90 of Armstrong's guns in one vessel, including first cost and current expense of men and ship for one year only, would amount to the greater part of £100,000.

It may not be deemed advisable to reduce the crews to the extent implied in the foregoing; nor could it be so done with existing ships, though

their armaments were changed, yet it cannot be that such large crews shall be retained only because of large masts and sails; ships must be built that will not require such.

At no distant day Armstrong will suggest modifications in existing ordnance and their carriages as will better adapt them to the object for which they were intended, and admit of a reduction of the number of men required for working them; so on all accounts ships that require large masts and sails will fall into disuetude.

Cutting the "Gemappes" down and covering her sides with iron plate suggests a doubt of the propriety of building ships of the line, even though they were suited to undergo a similar transformation. It it very much to be doubted that this ship will prove a good sea-going ship, and yet, owing to her small breadth as compared with her immersed depth, and the large amount of ballast she carries, she will be much more likely to yield a satisfactory result than any in our service.

I had hoped to have given some proofs drawn from recent trials; if any have been tried, they are kept from us, the principal effect of which is to keep naval officers ignorant, and naval architecture unimproved.

Our dockyards having been for a long series of years the largest ship-building establishments in the world, and vessels of the greatest diversity of form having been built in them, we ought to possess an amount of experience, limited by no personal pecuniary considerations, as all experiments have been at the public expense, and a mass of facts that, if tabulated and used with ordinary intelligence, would have prevented the necessity for our copying the French floating batteries, as we are said to have done, at a cost of well nigh half a million, and have afforded a guarantee against other eminent failures that have occurred from time to time.

The subject is vastly too important to be treated in the flippant way it has been, even by professional men,—another illustration that they get into ruts which those outside are the first to discover.

I have stated my opinions decidedly, because I feel assured that the whole subject of naval architecture requires reconsideration, and that our ships should be designed on some more definite and satisfactory principle than they are; and because I feel strongly that the nation which fully adopts Armstrong's gun, and all the measures necessary for developing its great powers, will be benefited to an extent that no numerical advantage of ships and guns similar to those now in use can counterbalance.

In this case the invention will prove vastly more advantageous to us, as it will enable us, while increasing the efficiency of the *materiel*, to place the *personnel* of the navy on a sufficient and entirely satisfactory footing, without further taxing the springs of industry.

Sir WILLIAM ARMSTRONG, Kt., C.B.—In consequence of the injunctions at present imposed to secrecy, there is but little I can say on the subject of rifled guns, but there are a few points connected with the trajectory of the projectiles which I may observe upon.

In a vacuum the trajectory would be the same whether the projectile were elongated or spherical, so long as the angle of elevation and the

initial velocity were constant; but the presence of a resisting atmosphere makes this remarkable difference, that while it greatly shortens the range of the round shot it actually prolongs that of the elongated projectile, provided the angle of elevation do not exceed a certain limit, which in my experiments I have found to be about 6°. This appears at first very paradoxical, but it may be easily explained. The elongated shot, if properly formed and having a sufficient rotation, retains the same inclination to the horizontal plane throughout its flight, and consequently acquires a continually increasing obliquity to the curve of its flight. Now the effect of this obliquity is, that the projectile is in a measure sustained upon the air, just as a kite is supported by the current of air meeting the inclined surface, and the result is that its descent is retarded so that it has time to reach to a greater distance.

With regard to lateral deflection, if from any cause the axis of the projectile should become inclined to the vertical plane, the resistance of the air operating on the inclined surface will press it to the right or to the left, according to the direction of such inclination.

The causes of the axis thus deviating from the vertical plane are somewhat complex, but are due to the manner in which the atmospheric resistance operates upon the under surface of the projectile in relation to the upper part, and upon the curved or conical end in relation to the cylindrical part. As a general observation, I may state that a rotation from left to right (looking on the upper side) will produce a deflection to the right, but the more the form of the projectile approaches that of a simple flat-ended cylinder the less will be the amount of that deflection. In fact, when a rounded or conical end is altogether absent, the deflection will even be reversed or take place to the left. Another cause of deflection exists in that class of projectiles which have projections upon them for the purpose of taking hold of the rifled grooves. Such projections act as fanners upon the air, but not with equal effect upon both sides of the projectile, inasmuch as the air is condensed on the one side and rarified on the other. It becomes an important point therefore to determine at what part of the projectile such projections should be placed so as to produce the least possible disturbance of equilibrium affecting the axis.

The deflections of which I have been speaking are of a permanent character, but it is the variable deflections which are the most difficult to deal with. I cannot here enter upon this part of the subject further than by stating that want of fit in the gun is the principal cause which produces irregular deflections in an elongated rifled projectile.

With regard to the application of rifled guns in ships of war, I entirely concur with Captain Fishbourne in what he has stated as to the importance of a steady platform. I think also the number of guns in a ship should be very much less than at present; but that the power of each should be as great as possible. Numerous guns involve crowds of men, and produce so much smoke as to render it impossible to aim. But, above all things, it is important in introducing these guns that the training of the seamen in the use of them should be proportionate to the more refined character of the weapon; and I earnestly hope that the Government will take effectual means to ensure the adoption of a proper system of instruction.

THE

Journal

OF THE

United Service Institution.

VOL. III. 1859. No. X.

LECTURES.

Tuesday, March 1st.

Major-General STANHOPE, Vice-President, in the Chair.

NATIONAL DEFENCE, OR NEW STRATEGIES IN WARFARE.

By J. MACKINTOSH, Esq.

THE important question of rendering our navy more efficient as an arm of *attack* against Sea-face Fortifications is of such vital importance to the country, that I trust the following observations relative to the employment of combustible compounds in naval and military warfare may be considered worthy of attention.

In order more clearly to explain the nature of my remarks, I have classed them under five different heads—

1. Facilitating attack, by ships of war, against sea-face fortifications.
2. Facilitating attack upon earthworks.
3. The inefficiency of the ordinary shell and fuse as used during the last Russian war.
4. The destructive powers of incendiary shells when used against shipping, &c.
5. A method of preventing troops, &c. from crossing rivers by the aid of boats, pontoons, or other temporary bridges.

1. I must premise, before explaining my method of facilitating attacks by ships of war against *sea-face defences*, that the weakness of our navy was sufficiently demonstrated when the Allied Fleets openly went in and attacked the sea-face batteries of Sebastopol, and very soon withdrew out of range, only to renew partial attacks, either under the favouring cloud of a Black Sea fog or the darkness of a starless night.

This is *convincing proof* of the *inadequate power* of our navy in attacking such strongholds; it is *not*, therefore, by *increasing* the number of our steam-ships that foreign States can feel our supremacy on the seas, but by holding in hand an efficient "*incendiary steam naval brigade*," which would enable us during war effectually to destroy all their ships and colossal fortifications.

My method consists in attaching to our navy, as an auxiliary power of attack, an incendiary naval steam brigade, consisting of small and inexpensive steamers, having suitable iron compartments filled with my combustible compound, composed of prepared coal tar naptha, which can be easily obtained in any quantities, and at a trifling cost.

When sea-face batteries are to be attacked, the admiral commanding a fleet (choosing wind and weather), when nearly within range of the enemy's guns, starts one of the small brigade steamers, containing my inflammable material, having previously ignited a time fuse leading to a bursting charge; the steamer is then permitted to proceed towards the enemy's batteries, with her helm suitably adjusted. On exploding the bursting charge, the inflammable fluid is scattered on the surface of the water, causing its immediate ignition, and producing a *dense black suffocating smoke or vapour*, which, driven by the wind against the sea-faces, enters the embrasures, and either suffocates or drives away the enemy's gunners, leaving the forts in our possession.

By another mode of application, the admiral commanding the fleet could (choosing wind and weather) discharge a sufficient quantity of this fluid upon the surface of the water, allowing it to be propelled by the tide or wind up to the sea-faces of an enemy's batteries, and then cause its ignition by the projection of a shell or rocket containing naptha and potassium ; by the great affinity of the latter for oxygen, the floating liquid (which cannot mix with the water) will be immediately inflamed, producing a *dense black suffocating fog or vapour*, which envelopes the fort or battery, rushing into the casemates or embrasures, and which, driving away the gunners, would enable the attacking vessels (under cover of the black suffocating smoke) to approach the enemy's works and take up positions necessary for pouring in their broadsides, and thus to destroy the forts, unmolested by any hostile fire.

2. In facilitating attack upon earthworks, I have diaphragm shells filled with compositions which will burn as well in mud as in water, and, when a shell containing them bursts in mud or earthworks, the bursting of the charge ignites the inflammable material, and, the earth being porous and incombustible, prevents the combustion from spreading rapidly, but allows the *black vapour* to ooze out gradually, causing most serious annoyance to the enemy, who are utterly unable to extinguish the suffocating smoke, and are thus hindered from carrying on their operations.

3. With respect to the inefficiency of the ordinary shell and fuse as used during the last Russian war, it is well known that a heavy percentage of our shells, either burst in the air, falling short of the mark, or did not burst at all, owing to the shortness of the fusees, and often from their composition *not* being impervious to damp.

With respect to their destructive properties, it appears that in one week's bombardment, during the siege of Sebastopol, about 6,000 tons of shot and shell and from 1,500 to 1,600 tons of powder were used—yet no sensible impression was made on the Russian earthworks, for the damage done to them by the allied batteries during the day was generally repaired during the night by our energetic and gallant enemy, so that the Allies expended nearly all their shot and shell with comparatively trifling results.

It will be seen from the description I have already given at No. 2 that had diaphragm shells, filled with my compositions, been used during the siege against the enemy's earthworks, their destruction would have been certain, owing to the composition contained in those shells being ignited and absorbed by the porous and moist ground, out of which a black suffocating smoke would issue, thus preventing the enemy from extinguishing the same by any amount of water thrown over it, besides hindering them from repairing their works during the darkness of night.

4. The destructive powers of incendiary shells, when used against shipping, are fearful, as the inflammable material with which they are filled, being scattered in all directions (on explosion), would cause the destruction of any ships of the line on account of the impossibility of extinguishing it.

5. By my method of preventing troops, &c. from crossing rivers by the aid of boats, pontoons, or other temporary bridges, I allow the enemy to construct or place their bridge, or pontoons, and then permit any desired number to cross over, and, being thus divided, I cause a quantity of the material before described to flow into or upon the river, and among the pontoons.

The material or composition being ignited, the pontoons with the advancing troops are instantly surrounded with a devouring flame and a *black suffocating vapour*. Should there be a current in the river the material may be discharged accordingly, above or below the pontoon bridge, and allowed to float or drift thereto, and, when required, it can be inflamed by a shell, projectile, or other means best suitable.

The enemy thus become divided beyond all hope of reuniting, and the advanced portion being cut off from assistance or retreat, consequently falls into the hands of their opponents.

In the present "*reconstruction of the Navy*," no doubt the *number* of our *steam line-of-battle* and other ships of war will be increased, but augmenting their number merely adds to their power of *defence* and *attack* in *open sea*, as no increased efficiency in their powers of attack against "Sea-face Defences" is obtained.

We may have a splendid and costly steam fleet roaming up and down the English Channel. They may watch the opposite coast, and have an

eye on "*Cherbourg*"—that impregnable stronghold and safe anchoring-ground of the French Fleet; but should, unfortunately, at any time a war ensue, *dare they* even attempt to force an entrance within *that* harbour, when the garrison, unaided by their ships of war, can at any time concentrate a fire of *about two hundred guns* upon either entrance—sufficient, indeed, if well-directed, to sink the finest ships in the world?

I have already recalled to your recollection the fruitless endeavours of the *magnificent* allied steam fleets, when they *openly* attacked the *sea-face defences* of Sebastopol, and in thus bringing the subject to your notice I do not wish it to be supposed that I am in the slightest degree anxious to throw any blame on either commanders or men; but what I *most distinctly* desire to do is, to expose the *true weak side* of our navy, and to *propose* and *explain* an efficient remedy. By so doing, I conscientiously believe that more ultimate benefit will accrue to the national interests than by withholding information which I conceive is of such paramount importance.

Friday, March 4th, 1859.

COLONEL THE HONOURABLE J. LINDSAY, in the Chair.

METEOROLOGY.

BY REAR-ADMIRAL ROBERT FITZROY.

AN apology should be made for presuming to address you on a subject so familiar as that of wind and weather, even when dignified (I will not say mystified) by the term meteorology.

Yet acquainted as all are, more or less, with the causes and consequences of changes in the air we breathe, or in the water, which is scarcely less important to existence, it may be interesting, and one may hope useful, to endeavour to illustrate some of their remarkable features clearly and comprehensively. If they should be less philosophically treated than might be desired, I must hope that allowance will be made for a practical man, who has not graduated regularly in science, and therefore must be deficient in the higher acquirements. It is as a practical observer of nature, especially at sea, aided but little by books, that I now venture to ask for your attention to some few points in meteorology which may be so far popularised as to be useful in every-day life.

But what is the precise meaning of the term "meteorology?" a stranger may ask. "It is the science treating of air and water, wind and weather, heat, cold, and climate," may be replied.

As time is limited to the reasonable space of one hour (long enough to exhaust the patience of most hearers), I will premise briefly what is proposed to be submitted to you this day, and the subjects which are intended for notice next Friday.

First, I would endeavour to give a general view of the atmosphere, in order that the explanations subsequently offered may be properly understood, and then I will make very brief allusions to some of the most useful instruments, not going into or attempting anything like a complete description, to those who are more conversant than I am with most of them, but simply alluding to particular points in which certain instruments *now* adopted are supposed to be better than those which were used some years ago, and drawing attention to some of the novelties in them.

After having given this general reference to the instruments, I would try to show how they may be made most practically useful in every-day life, by foretelling weather, advantageously to the soldier, as well as the seaman and traveller, besides the farmer, the gardener, and the medical adviser. I would then very briefly glance at the ocean with reference particularly to the endeavours to explore its depths, because it is a matter of immediate interest—and if time should allow, I would refer briefly to the effects of changes in the atmosphere, and particular winds, on climates

generally; but this, probably, must be put off till next week, when what is commonly called "cyclonology," or the investigation of circular storms, in connection with the general winds, and the movements of the atmosphere, called sometimes (whether correctly or not) "atmospheric waves," a much-disputed question intimately connected with the barometer, will be considered. These being rather more scientific, may be deferred at present.

Speaking now of the nature of our atmosphere:—It is very commonly remarked that air is a fluid, and that all fluids are much alike. Air is a fluid, water is a fluid, gases are fluids. Very true—but there are these remarkable differences between the fluid, *water*, and the fluid, *air*. Water is almost incompressible and inelastic. It is composed of two gases, which are mixed together *chemically*, oxygen and hydrogen—the water, not being elastic, exerting no force to spread itself, except in common with other fluids by seeking its own level, with reference to the centre of the earth (or gravitating towards the centre of the earth). All fluids have that property in common, they all gravitate and seek to attain a uniform level. But air has the peculiarity of extreme elasticity. It is not only fluid as water is fluid, and therefore seeking to maintain its equilibrium (with reference to the centre of the earth), but it is always more or less under *pressure*, and if that pressure be relaxed, ever so little, it expands immediately. It has a constant tendency to *expand* in every direction. Water only spreads.

About 15 lbs (everyone knows) is the weight of the atmosphere pressing upon every square inch of surface at the level of the ocean. This pressure may be relaxed, locally and temporarily, by air being withdrawn, or lightened by heat around the locality, by being rarefied above it, when immediately the air around expands, seeking to fill up the space of lessened pressure. If you draw a part of the air out of a room, the rest of the air in that room will fill the remaining space, as air is capable of very great expansion. I do not know whether ascertained, but believe it is nearly indefinite. Why I would lay stress upon this point now is, because it immediately affects the barometer.

But this is not the only reason why, when air becomes more expanded and lighter, the barometer, which weighs the air, sinks, but also from the watery vapour, invisible, but in the air itself, as *gas*, expanding by heat and occuping more space.

By the expansion of this gas, air becomes lighter; and, bulk for bulk, a given space full of warm air with expanded watery gas (or aqueous vapour) is lighter than an equal bulk of dry air. This is another reason for the mercury in the column of the barometer falling in certain states of the weather, and rising in others. Upon this question, however, there has been much difference of opinion. Some authorities demur, and assign other causes. Some indeed think that the effect on the barometer is chiefly caused by *electrical* changes; but, while we *have* simple and general causes intelligible to all, and which we know, from experiments easily made, do take effect, I do not see why we should look only to the mysterious workings of electricity, although its (secondary) results are occasionally remarkable.

The effect of the atmosphere upon the thermometer—the ordinary

motion of the column of mercury in the thermometer—everyone notices almost daily.

The barometer is used not only for the common purposes of a "weather-glass," but as a scientific instrument, and for measuring heights. I refer also now to the use of the "*boiling point thermometer*," to show the little reliance that can be placed upon this instrument, as compared with the barometer, for measuring great heights; and I mention it particularly, because within the last few years much stress has been laid upon the measurement of some very remarkable mountains by boiling water. Each degree of the thermometer is equivalent to about 550 *feet of ascent*, or one-tenth to 55 feet; therefore, the smallest error in the graduation of the thermometer itself will affect the height deduced materially.

In a thermometer which is graduated from 212°, the boiling-point, to 180°, similarly to those intended for the purpose of measuring heights, there must have been a starting-point, or zero, from which to begin the graduation. I have asked an optician in London how he fixed that zero, the boiling-point: "By boiling water at my house," he replied. "Where is your house?" In such a part of the town, he answered. I said, "What height is it above the sea?" to which he replied, "I do not know;" and when I asked him the state of the barometer when he boiled the water, whether the mercury was high or low, he said that he had not looked at it! Now, as this instrument is intended to measure heights and to decide differences of some hundred, if not thousand, feet upwards, at least one should endeavour to ascertain a reliable starting point. From inquiries which I have made, I believe that the determination of the boiling-point of ordinary thermometers is at present very vague, not only from the extreme difficulties of the process itself, (which are well known to opticians,) but from the radical errors of not allowing for the pressure of the atmosphere at the time of graduation—which may be much, even an inch higher or lower than the mean, or any *given height*, while the elevation of the place above the level of the sea is also unnoticed. Then there is another source of error, a minor one perhaps: the inner limit, the 180° point, is fixed only by arbitrary measurement, by comparison with another thermometer; it may be right or it may be very much out, as may be the intermediate divisions, for the difficulty of ascertaining degree by degree is very great; and it must be remembered that the measurement of a very high mountain depends upon those inner degrees from 200° down to 180°, and thereabouts. Hence the difficulty of fixing them upon the thermometric scale, and of making a reliable observation by boiling water, may be greater than has been generally supposed and admitted.

By one of the boiling-point thermometers to which I referred, may be seen at once how very small the degrees in the small space ranging from 180° to 212° must be, while even their starting point is not reliably fixed.

There is an application of the thermometer which would be used advantageously and frequently, if more generally known. I mean the common moistened or wet bulb thermometer, used with a dry one as a "Mason's" hygrometer. One thermometer being moistened, is kept cool by evaporation and shows its temperature. The two thermometers need

not be placed quite together. You may hang either in one place and the other pretty near it, but not close, provided that they are under the same conditions, or in similar circumstances. The bulb of one should be kept moist, (not wet, but simply moist,) so that evaporation may go on, and then that thermometer will show the temperature at which water is taken up and converted into invisible vapour; while the other will show the temperature of the air. The difference between the two, doubled and taken from the lower, shows very nearly the "dew-point;" or that at which dew is formed (as on a bottle of water brought out of a cold place, when, according to the lower temperature of the water within, the deposition will take place, sooner or later, by the vapour in the air beginning to be condensed into moisture). Hence you may know whether the air is more or less moist, whether rain is likely to fall or not, or whether your room is too dry or too moist. It is a very simple instrument, and, if more freely used, might become very much more popular. At present it is generally thought rather too scientific, and so much notice is not taken of it as should be. In connection with the barometer, it affords an almost unfailing warning of the weather that is coming on, as I will show subsequently.

The Kew marine barometers, which are now much used in the navy, and frequently in the merchant service, are made of glass, iron, and brass. The old barometers used to be generally cased in wood, and had wooden cisterns with leather bags. It is supposed that a metal barometer, with a glass tube securely fixed in it, can be graduated with greater accuracy, and is more reliable in its indications, than a glass tube in a wooden case. The French, however, have been hitherto of a different opinion, and use the wooden case: but they are now instituting investigations, with a view of proving the question. The English opinion has been that wood, being hygrometric, alters its length, and therefore the graduations are liable to be incorrect. That is one disputed point. Then the method of securing the tube in the cistern is said to be more manageable in wood. The English opticians, however, who probably have more experience on their side, say that it cannot be well and permanently fixed in wood, because climate, moisture, heat, and cold alter the casing, the cistern, and the leather, so much that the instrument becomes deteriorated, and lets in air, while the position of the tube is more or less altered. In an iron cistern the tube is securely fixed, so that it cannot vary upwards or downwards. Some think it is too securely fixed, and therefore it is liable to be broken by concussion more readily than that of an inferior instrument. This, however, appears to be a necessary consequence of greater exactness, and if exactness is requisite the tube must be fixed securely. It is not generally known that this instrument is not graduated to exact inches; the inches are artificial, and so spaced as to show the correct height of the column (compared with a standard barometer, by trial and error), so that after the instrument has been graduated and thoroughly verified by the proper process, there are no corrections requisite to be applied to it except one constant, for scale or index error, and one varying, for temperature. None of the corrections depending upon the size of the tube and the relative size of the cistern, and for capillarity, which are necessary in some land standard barometers, are required in these,

which, after being verified in a reliable observatory, such as that at Kew (established by the British Association for the Advancement of Science), become valuable as standards.

It may not be generally known that the only difference between such a barometer, and a barometer used on land, is that the upper part of the tube is alone carefully measured (or calibrated, as it is termed). Upon the nicety of that part of the tube the value of the instrument chiefly depends; the size of the other part is of little moment, for whether the interior bore is greater or less, makes very little sensible difference to a barometer made upon the Kew principle. Whatever constant errors exist, are proved by actual "trial and error," and allowed for in the graduation, which, as I said before, is *artificial*. The part of the tube contracted to prevent the mercury from "pumping" (or oscillating with the motion of the ship) may be 2 or 3 inches long, or it may extend the whole length. In most of the old marine barometers, the contracted part extends the whole length, but in this one it is only about 2 inches. Below this there is a "pipette," or a little funnel with the point downwards within the tube. The air, which may work its way in, never goes *through* the mercury; it always passes between the mercury and the glass, so, by having this funnel within or near the top of the tube, any air which goes up by the side is stopped at the shoulder and there remains; the mercury itself working up and down through the middle of the funnel. After a barometer has been some time in use, if any air has got into this part of the tube (and it cannot get beyond, or into the upper part, when it is thus constructed), or when there is reason to suppose that air has got into this part, you have only to turn the lower end of the tube upwards and tap it gently, when all the air will gradually go out, and pass into the cistern again, the barometer tube thus becoming freed from it.

During four years that the office has been established in which I am employed, such instruments have been sent out, and returned from voyages on board merchant ships, as well as men-of-war, sometimes for two or three voyages successively, and most of them without injury. In the first two years several were broken; but chiefly, I may say, through unduly rough usage, several being from the near concussion of guns on board men-of-war. In one instance the barometer was hung immediately under a heavy pivot-gun, which was fired just over it, when, of course, such an instrument could not stand the shock. Others were placed between decks where men in exercising ran against them, and it thus happened that many were returned "broken," from men-of-war, during the first two years. During the last two years, however, there have been very few breakages; while from merchant ships during the four years, not 5 per cent. of the whole number afloat, out of several hundreds that have been supplied, have been broken; so that as far as experience has gone, they have stood common work very well. They have been sent by railroad, in a manner which the old-pattern barometers could not have borne, and have preserved their merits. Not only is the cistern itself a fixture, as it were, requiring no opening and no adjusting, but the little funnel within the tube prevents the air from getting into the part of the tube upon which accuracy depends. Within even the last month, I

have had the testimony of other authorities, in addition to that of the Astronomer Royal for Scotland, to the effect that these barometers are equal to any work for which standards are required on land or at sea.

Still I think another kind of barometer might be found better for men-of-war, with reference to the concussion of guns—that it might be made upon the syphon principle, and graduated on the glass itself.

The tube of a Gay Lussac mountain barometer is on the syphon principle; there being no air in the long tube, the mercury falls to a certain distance when the short tube, which corresponds to a cistern, is open. When this short tube, or leg, is opened, the mercury rises to a certain point according to the atmospheric pressure, just as in the cistern and column mercury acts in other barometers. The scales slide, and you measure from the level of the mercury in the long tube to that of the mercury in the other, so that all errors, excepting those caused by temperature or a defective graduation of the scale, are obviated. It is the simplest of all barometers in principle, but difficult to deal with at present, because the mechanical construction is critical. It is rather curious that these instruments, perhaps the best mountain barometers of the present day, are now made in England by a person who is employed by the principal opticians, while he is ostensibly keeping a hotel not many miles from London, though the sole maker in this country, who is now reliable.

These Gay Lussac barometers have been taken to many parts of the world, and have been found to answer exceedingly well, when duly cared for. Some however say they are too brittle, and cannot easily be carried by travellers.

My principal object in referring to them was to show that I thought a barometer upon nearly such a principle, with a very strong and graduated tube, might be made available for men-of-war, which require a barometer far stronger and less brittle than any of the instruments that are now in use. When Sir John Richardson went on his land journey to the Arctic regions, he wished to take a barometer that would bear rough usage in travelling, and he had one made on his own plan. It went with him and came back uninjured. He had some spare tubes. It was very strong, and would not run any risk unless hit very hard. It is graduated upon the tube itself, which is an eighth of an inch in thickness, and will stand rough usage. The tube has an iron screw securely fixed upon it, which goes into the cistern. The cistern can be carried in one place and the tube in another: the tube being in a wooden case by itself, and therefore not liable to be broken by having the weight of any mercury in it. The filling it properly, requires a long elastic tube or funnel to go down to the bottom of the glass tube, through which the mercury may be poured in carefully, beginning at the bottom, so that as it fills the tube it forces the air out before it. You fill it quite full, with the cistern screwed on and held up; then screw up, by the bottom screw—reverse, and take out the little screw, through the hole for which a certain quantity of mercury may be withdrawn by a small syphon till the mercury's level is at the *marked* neutral (or starting) point. With a little syphon made of glass, or wood (on the principle of that which is put into a cask), as much of the mercury as you choose may be withdrawn; or, the

tube may be screwed more or less into the cistern, till the mercury is exactly at the mark. I do not say that a barometer thus roughly constructed (with *unboiled* mercury) can be compared with the accuracy of a more scientifically constructed instrument, such as our first opticians would make; but I believe that it would be very much more reliable for travellers (within certain limits of error) than boiling water thermometers, or Gay Lussac barometers, or any other means that we have at present, because it is strong, it is very portable, the limits of error are known, and they are not too great for use. I believe that one would get the actual pressure of the atmosphere anywhere within *two-tenths of an inch*; which, when measuring a mountain from 12,000 to 20,000 feet in height, would correspond to but a small quantity, namely, about 200 feet of altitude, a difference much less than the uncertainty of corrections necessary for temperature, and other circumstances, at a great elevation. The instrument before you is the identical one which Sir John Richardson travelled with and brought back uninjured.

Merchant ships which have been supplied by the Government with instruments during the last three or four years, and many men-of-war that have been supplied, had at first thermometers with metallic scales, which came back after a voyage in a rusted and illegible state. To obviate that a white porcelain scale was brought into use, which answers remarkably well. It is made like a plate, the scale being baked with the *larger* figures on it, the maker's name, and all that can be placed, without extreme accuracy being required, before graduation. The exact marks for the graduation of the scale are then cut in, or etched, and the marks blackened with nitrate of silver or some other chemical preparation. Thus, the scale not being put into the fire again after graduation, these thermometers remain without change of form, size, or colour. They can be easily read at night, and are perhaps the most useful that have been made.

Another kind was previously tried, namely, slate: but was found to be too easily defaced, and on the whole it does not answer so well as porcelain or earthenware, neither is it so easy to read at night; porcelain is altogether preferable.

Some thermometers, merely for scientific investigation, have a blackened bulb, and, if *in vacuo*, the air is exhausted out of a glass globe which incloses the bulb. The sun's rays striking upon such a blackened bulb, in the focus of a reflector, cause the greatest degree of heat at the time and place. It is for trying experiments in various climates with a view of ascertaining the intensity of the sun's heat under various circumstances, and is a contrivance that has only been effectually completed within the last few months.

Various anemometers, wind-gauges or wind-measurers, have been brought into use lately, and within the last few days two such instruments, on the most approved principles, have been sent out to Halifax and Bermuda by the Government (one by the Board of Trade and the other by the Admiralty). The principle upon which those anemometers measure the wind can be shown by a little instrument (intended for use on board ship) mounted on gimbals like a compass, in order that it may remain horizontal under any motion of the ship. It was found by Dr. Robinson

(of Armagh) that the shape of a hemispherical cup (exactly the half of a sphere) offered a third greater proportion of resistance to the wind on the concave side than on the convex side, and that the velocity of such cups, when put in motion by the wind, is one-third that of the wind, nearly, the wind exerting a third greater force upon the hollow side than it does upon the convex side.* This fact being known, the measurement of the velocity and force of the wind is comparatively easy. The proportion is not quite exactly three to one, but very nearly so. Such an instrument may have a self-registering apparatus with clockwork or dials, like those of a gas meter, to register the velocity of the wind in a certain time; the force may be ascertained by comparison with a pressure-plate, or by calculation. The instruments that are sent out to Halifax and Bermuda upon the same principle are large and self-registering. There is an apparatus attached to them of wheels and rollers, with paper fixed on the rollers, so that in whatever way these cups move their indications are registered by the machinery below, connected with a clockwork moving cylinder covered with paper, and a pencil making the indications. All is so well contrived, that it is only necessary to look at and change the paper once a day (Osler's and Robinson's principles combined).

An attempt has been made to obtain a hand instrument, which is much wanted. At present the measurements of wind on board ship are merely estimated. Lind's wind-gauge, modified by Sir William Snow Harris, and altered subsequently, may yet effect the object in view, which is to get an instrument that you can hold up to the wind. A level which it has, shows when it is exactly horizontal; and the means of opening while holding it to the wind, and shutting it instantly at pleasure, are effected by a touch. It is Lind's wind-gauge, with a means of opening and shutting the orifices. The wind blows in, pressing the fluid to a certain distance along the graduated tube according to its strength; your thumb at the back keeps the instrument open till you choose to shut it, when you may read off. It is not perfect, but I believe it will be a tolerable approximation to a wind-measurer. The level is on the principle of the very simple "Peruvian level," that by which aqueducts in Peru and Mexico were carried out, namely, a hollow cane or bamboo half full of water with an opening and a float near each end, the floats carrying marks of an equal height, and the cane being placed so that the observer's eye might be in a line with those two marks (just as the eye should be in a line with the sights on a gun). When the two points are in one line with the eye the level line is shown. The late Sir Francis Beaufort was exceedingly anxious for some instrument of this kind. His scale, a very good one for merely *estimating* the force of the wind, became generally adopted, not only in this country but in America and France, yet he wanted something of this kind to verify and use with it. I do not say that the gauge described will quite answer our purpose, but something of the sort may give means of actual approximate measurement, instead of arbitrary estimation.

The atmosphere consists of very minute particles, far smaller than can

* The effect of friction is not considered, because, when well mounted and furnished with friction balls (rollers), there is in effect no sensible amount of retardation due to friction.

be shown by measurement, or that we can realize to our conception. A glass containing very small shot (dust shot), compared with another glass containing large shot, may help to illustrate what I mean when saying that different gases—the different component parts of the atmosphere—may differ very much in their mechanical nature, as to their particles (smaller or larger); and that the particles of one kind may mix among those of the other, between their interstices, while another substance, such as perhaps heat, may mingle with those various particles, as water mingles in such glasses with shot. A good deal of water can be mixed with such shot before all the interstices are filled—and so it is in the case of particles of atmosphere. I refer to this as a practical illustration of one gas mixing with another, and of vapour or heat being spread through a portion of air, without increasing its apparent bulk, being sensible to the eye, or the contrary.

Supposing that the air over any place at which the atmosphere is lightened or rarefied, by heat insinuating itself between the particles of air, they are expanded, become lighter, and occupy greater bulk, therefore equal cubes weigh or press less. A body of air then ascends; and it acquires a certain momentum which carries it on; but, having left a particular place, other air *must* come into that place, which cannot be a vacuum. Being raised by its comparative lightness, it ascends, and other air pushes in immediately from all space around to fill its place. In a room, for instance, rarefied air goes up towards the upper part, and cold air comes in from below, if there is an opening for supply.

Upon this simple general principle, the principal phenomena of wind in our atmosphere depend chiefly, I will not say entirely, because there are local, temporary, chemical, and electrical causes; but the great principle upon which the movements of the atmosphere generally depend are simply these: the rarefaction and rising of a body of air, the place of which is filled by other air coming in from the readiest source of supply.

Supposing that a diagram represents the world's surface from one pole to the equator and the other pole (a section through the globe from pole to pole); if the air is rarefied at the equator, and ascends in a body, we have shown that other air must rush in to supply its place. The trade winds continually blow towards the equator; the heated air thereabouts cannot go up beyond a certain distance, where it becomes cool, and is prevented by gravitation from going beyond a certain distance from the earth's surface. It can only go laterally. Pressed upon still by air rising from below, and by the constant * pushing in of other air, it flows over laterally, and makes its way *towards* the poles; but before it has passed beyond the tropics, there is a demand for it below, or underneath, from the places it is passing over (in about the northern extremity of the tropics, from 25° to 30°); and if the supply is at any time failing from the poles, the cooling and sinking of the air about that part (30°) will tend to supply the want at the equator: thus there will be (what I will another day endeavour to explain more distinctly) a double action; there will be a pressure downwards of the upper returning current, which has been cooled and dried to a certain extent, on its way to the pole, a pressure of this returning current about the latitude of 30°, and a pressure at the same time from the polar regions, which are generally supplying

* Vis a tergo.

the want caused by the sun's heat rarefying and making the air ascend at the equator.

This double, or concurrent, action is probably a chief cause of the constant accumulation of air, and a greater pressure of atmosphere about the (so called) "horse latitudes," near 30°, where the barometer all the year round stands higher than anywhere else in the world, on an average, if not in extreme cases. I allude to this with a view of showing how the simple principle of the rarefied air ascending, and its place being supplied by colder air, is carried out in the movements of winds, by supply from the colder places, or poles, and the upper currents of returning air. No air can escape from the attraction of the earth; it cannot go beyond a certain distance. Whether our atmospheric air extends further than ten or twenty miles can only be conjecture; perhaps beyond that distance there may be far lighter gas than our own mixed air; there may be much hydrogen, which is the lightest of all gases; but no experiments that have yet been made have proved with certainty what are the constituent parts of our atmosphere beyond five or six miles upwards.

I may here, with reference to some intended observations, allude in the same brief way to the combined action of the earth's rotation with the circulation of the atmosphere. As any body of air which we suppose to start from the equator is making its way northward, whether stopped at the latitude 30°, or carried on to nearer the pole, the earth itself is turning; and the consequence of these combined actions is, that instead of that body of air going direct towards the pole, as the earth turns, this said mass of air, having the velocity of the equatorial part of the earth (not of the polar part, which turns very slowly), moves eastward as it goes northward, and its actual course is towards the north-east.

On the other hand, the cold air from the pole, which starts southerly, meeting parts of the earth that are turning faster and faster, comparatively, is left more and more behind, and becomes while going towards south and west, north-easterly and easterly in effect. There can be no doubt (on the authority of Herschel and Dové, the two first meteorologists,) that such is the system of our winds, and that if referred to when using instruments shewing the pressure, direction, elasticity, and composition of the air, the facility with which nearly all that takes place in the atmosphere can be foretold or explained becomes satisfactory beyond expectation.

One subject, that of clouds, may be only briefly referred to now, as there will not be time for more. A cloud is formed before you, or what may be called and is a cloud, when an urn is smoking or rather steaming on the breakfast table. Steam which ascends from the urn is at first, when it is close to the urn, invisible; but it spreads, becomes visible, and then is dissipated altogether, if not condensed on a cold substance. A cloud is watery vapour, in a state *between* invisibility and water. Perfect gas or pure steam is not visible: what we generally call steam is that same vapour slightly affected by the chill of the atmosphere, or partly turned to a cloud. Steam, when unaffected by external air or cold, is quite transparent. Directly steam expands into air, it is more or less chilled, and the first effect is an appearance of cloud; but as soon as the particles can diffuse themselves, among *comparatively* dry air, the aqueous vapour is taken up, and you see no more of it. The large clouds we see in the

air are comparatively near the earth, which is always much warmer than the air high above. A certain quantity of water can be held in suspension in an invisible condition within a given distance of the earth—that distance frequently varying according to the changes of temperature. A certain chill brings it down, perhaps at once, in rain, but between the state of rain, the actual deposition of moisture, and invisible vapour, there is that state which takes place when vapour is only chilled, as seen in clouds. A considerable amount of cold acting upon aqueous vapour existing in an invisible state in the atmosphere turns it into water, condenses it, and then down it comes as rain. If there is not a great amount of moisture, and if it is simply chilled, it becomes like mist or fog. It does not fall in rain, but is like the mist which you see rising from boiling water.

If you go into a laundry when there is much washing going on, you probably find the whole of the upper part of the room full of steam. That steam is cloud, which cannot get away—being confined in the room; if it could get away into the air it would be taken up by the drier air and apparently dissipated, just as a sponge takes up a certain quantity of moisture. The air is generally in a state that will enable it to take up a certain quantity of moisture (more or less according to temperature and other conditions); but as aqueous vapour in the air is invisible under ordinary circumstances, and when condensed by sufficient cold becomes rain, there must be immediate states between the two, which intermediate states are the varying conditions of clouds which we see above our heads, in every condition and form.

Fog and the cloudiness in a room full of steam are similar varieties of aqueous vapour.

Many gentlemen in this room have ascended high mountains and passed through clouds. They found that the clouds, when they were in them, were just like fog, that they got above, and completely out of them, and that the chilly air alone seemed to keep vapours in a visible state.

This appears to be a simple explanation of appearances which some have connected entirely with electricity, and have tried to explain more elaborately; but it has been generally found that nature's works on the greatest scale are precisely similar to her operations on the smallest, and that, what is true of water or vapour of any kind, in a small room, is, if the right principle be fairly carried out, true of all the operations of nature respecting aqueous vapour and water on the largest scale in the universe.

I must refrain from further occupying your time now. The subject is one upon which there is inducement to enlarge. Another day I will endeavour to refer more clearly to these subjects in immediate connection with Dové's "Law of Gyration," or rotation theory, and the (so-called) atmospheric waves.

One may call a simple diagram, a circle divided by a diameter from north-east to south-west, the thermometer compass. While the wind is shifting from south-west, by west, north-west, and north to north-east, the thermometer is falling, but while shifting from north-east, by east, south-east and south, towards south and south-west, the thermometer is rising. Now the barometric column does just the reverse. From north-east the barometer falls as the wind shifts through the east to south-east, south,

and south-west, and from the south-west, as the wind shifts round northward to north-east, the barometer rises—it rises to west, north-west, north and north-east.

The effect of the wind thus shifting round and traced upon paper by a curve seems certainly wave-like to the eye; but I believe it to be simply consequent on the wind shifting round the compass, and indicating alteration in the barometric column.

If the wind remained north-east, say three weeks, there would be no wave at all—there would be almost a straight line along a diagram (varying only a little for *strength*). The atmospheric line, in such a case, remains at the same height, and the barometer remains at 30 inches and (say) some three or four tenths, for weeks together. So likewise when the wind is south-westerly a long time, or near that point, the atmospheric line remains *low*, towards 29 inches. It is thought heterodox to say, *now*, that "atmospheric waves" are an optical delusion; but—as generally understood, such a misconception is asserted.

Such a diagram as alluded to above shows how the barometer and thermometer may be used in connection with each other in foretelling wind and consequently weather that is coming on, because as the one rises the other generally falls, and if you take the two together and confront with their indications the amount of moisture in the air, at any time, you will scarcely be mistaken in knowing what kind of weather you are likely to have for the next two or three days, which for the gardener, the farmer, the soldier, the sailor, and the traveller, must be frequently of considerable importance.

Among the objects to which meteorologists should chiefly devote themselves seems to be the selection of practically and immediately useful points, in the first instance, and purely scientific ones, for future objects subsequently. Among those most useful, probably simultaneous observations, once or twice in the 24 hours, by general concert of a great number of observers, will be found the most immediately available, because they give a bird's-eye view of the world's surface at a given time, and again synoptically for successive definite times, days, or weeks, perhaps months, from which may be learned what is the regular or irregular succession of weather, what may be expected, and what are the various causes and connected circumstances. Such a plan is now in progress, and we may hope in two or three years to know, at all events in the Atlantic, and the countries bordering on this nearest ocean, what is the usual course of changes and *sequences* of weather during certain cycles—to know beforehand what may be expected, and what changes certain occurrences will inevitably bring after them, so as to become enabled to turn such warning knowledge to practical general use.

CHAIRMAN.—I am sure every one who has heard Admiral FitzRoy's exposition of the subject must be deeply impressed with the ability which he has brought to bear upon it, and also the extreme clearness with which he has put the subject before us. When an officer whose time is fully occupied and deeply engaged in the public service (as Admiral FitzRoy's is) favours us, as he has done to day, our thanks may well be in proportion to his devotion to our service. I may offer him also, at the same time, the thanks of the COUNCIL of the Institution for occupying so much of his time in explaining the subject.

Friday, March 11th, 1859.

REAR-ADMIRAL SIR GEORGE BACK, D.C.L., F.R.S., in the Chair.

I will endeavour now to explain some of the principal and general movements of our atmosphere,—looking at the world as a whole, and referring to generally prevalent movements, not to merely local peculiarities.

Pray suppose that you are looking at a section of a globe from pole to pole as if looking at our world from a position at some distance outside of it, and taking in the view of a whole hemisphere, and then remember that the effect of the sun's heat, the constant effect throughout the year, is to warm and elevate, or *continue* raising all the body of air in the neighbourhood of the equator from many degrees, say ten or twenty, on one side to many (perhaps more) on the other.

Around the whole circumference of the world it is that zone of the atmosphere upon which the sun exerts the greatest and most constant power, the effect being to keep the air in that particular region continually rising. But it cannot rise beyond a certain distance, because the counter effect of gravitation towards the earth's centre acts. It also gets chilled and cold, after rising some miles from the earth's surface; but being continually pressed upon from below, by air still more recently heated, the upper air must flow away *laterally* (like water seeking its level) in the higher regions of the atmosphere, where it may be said to overflow. Meanwhile, to the lowest spaces adjacent to the ocean or land whence such air has risen, other air will press in from either side to fill what would otherwise be a comparative vacancy; such other air being cooler, and drawn from afar, whether from south or north, or elsewhere. Now that air which has been first warmed, expanded and raised,—then cooled in the upper regions—must go somewhere. It cannot go upwards beyond a certain limit. The consequence then is that it overflows, as has been shown, on each side, part going northward in a direction nearly corresponding with the shape of the earth's surface, or parallel with it; part going similarly towards the south—thus keeping up a continual movement of air towards the poles, *from all parts of the equator, all round the world*, while there is another tendency constantly of the lower air, from the poles towards the equator, *near the earth*. A grand and immediate effect of these constant currents, or as one may say of this circulation, is the phenomenon of the trade and (so-called) anti-trade winds prevailing within certain limits, the former from near the equator to 20 or 30 degrees on each side of it, all round the world, and the latter in middle latitudes, excepting where spaces of land intervene and, from their heat or cold, occasion local or exceptional differences. Speaking *generally*, these trade and anti-trade winds around the world, upon which navigators depend so much, are caused by ascension of the equatorial air, and a supply of its place by other air pressing towards the equatorial places of departure.

Now that cold air (cooler air) flowing in, must of course come from some great source of supply! *Where* is that source of supply, one may ask, in sufficient quantity? If you compare the size of the world in its equatorial regions, the bulk of it around the equator, with the *small area* near each pole, and consider that the world is constantly turning, the central part being very large and moving rapidly in proportion to the polar, where it has very slow motion, it will appear evident that the mass of heated and expanded air near the equator must be very much larger than the body of air near the poles. It is not only very much larger in quantity, but it has a rotatory motion, very rapid, nearly equal to that of the equatorial earth, which air near the poles has not. The nearer the pole the less the rotatory movement of the earth, the nearer the equator the more rapid that movement; and the atmosphere, which goes nearly with the earth, moves similarly. The result of these combined movements, those of the earth and air, is that warm air which moves towards the pole from the central zone has another impetus, with the velocity of the equatorial regions, and as it goes towards the pole while the *earth turns eastward*, moves faster and faster than the earth does as the polar regions are approached. If you throw anything out of the window of a railway carriage in motion, it partakes of your motion, and instead of dropping behind, it drops abreast of the carriage. So with air that rises from near the equator in its movement towards the poles; and the consequence is, such a prevalence of westerly winds in middle latitudes, that they are justly termed anti-trades. These prevalent winds are at first south-westerly, then westerly or north-westerly in the regions between the tropics and those of the arctic and antarctic circles.

The converse action, which is the easier to understand at first sight, takes place from the pole towards the equator. The mass or body of air or wind, starting from near the pole, moves towards the equator with little or no circular or rotatory movement, because the body of air within the arctic regions is *comparatively* slow in rotation, that part of the earth moving very slowly compared with the equator. Any body of air from polar regions then moves towards equatorial parts to fill the spaces being continually vacated there; but as it so moves the earth is turning to the eastward and the result is a diagonal, a more or less diagonal movement of any such body of air across the world's surface, causing north-north-east or south-south-east, or north-easterly or south-easterly, or easterly winds; *more* easterly as you get nearer the equator; so that the wind which we feel here as a north-east wind actually left the arctic region as a northerly wind, and, probably, when it has passed further south, will become sensibly more easterly. The simple effect of the polar current becoming more easterly towards the equator may be shown easily by moving a pencil from either pole of a common globe, on a stand, towards the equator direct, while the globe is turned eastward. The line traced by hand makes a diagonal (or rather a spiral) line nearly between the two directions. (It is spiral on account of the globular form.) This effect is easy to see; but the other movement, from west to east, and the reason why a body of air moving from the equator towards the pole goes faster than the surface of the earth over which it moves, is not so evident *at first*. It is only after reflection one sees

clearly that, the rotatory movement within some degrees of the pole being slow—compared with the rapid motion near the equator—if the air rising from the equator moves with the momentum of that part of the world, as it goes further towards the pole it must move faster and faster over the earth's surface in an *easterly* direction, and the result must be the general or prevalent westerly winds in middle latitudes, which have been lately and justly called by Sir John Herschel and others, the anti-trades.

Referring again to a globe, its poles and equator, we see that extensive central masses of air rise from equatorial regions, move *above* laterally and towards the poles, and that polar currents move nearer the earth's surface towards the equator. Owing to the convergence of the meridians (that is, their approaching nearer and nearer), all the meridians meeting at the pole, from larger spaces at and near the equator, the polar supplies are deficient, and are made up for by parts of the equatorial current, as will be shown. All the body of air round the equatorial region, large and expanded as it is, has a *tendency* to move towards the poles; but it *cannot do so*, there is not *space* enough for it; the law of gravitation acting through this fluid air, seeking its equilibrium, prevents its *rising* beyond a limit; when resisted and cooled it becomes compressed, and then struggles with the polar counter-current for room near the earth's surface. Suppose that a body of air at the equator (which has the above described double tendency, namely, to move eastward and towards the pole), starts from an equatorial place, and moves more and more westerly (from the westward) over the earth's surface as it goes towards the pole, because its motion in middle latitude is faster than the motion of that part of the earth from the west, and it goes, therefore, faster than the earth,—it becomes compressed into smaller space, and also—meets with the polar current making its way towards the equator,—by the turning of the world making a diagonal (or spiral) course which is north-easterly, and afterwards easterly when it gets near the equator. There are thus two conflicting currents or bodies of air, one making its way northward and becoming compressed, having its vapour condensed and (as it were) squeezed out of it by the dry polar current which it meets, and the other making its way towards the equator. The effect of the antagonistic currents of air in raising the barometer about the "horse latitudes," and the return of part of the upper current, when cooled and condensed, to the equatorial regions, has been already described in the first paper. We see the effects of these two conflicting currents in ordinary changes of weather in this country (nowhere more plainly) the wind continually going round by north, east, south, west, and north—round and round again in successive changes, comparatively seldom going round the other way, the retrograde motion being exceptional to the *general* rule, like the exceptional eddies which one may see in the currents of a river when streams are meeting one another, the eddies generally turning one way, but occasionally from some local circumstances, turning contrariwise, as exceptions to the general rule of direct change, which is as the hands of a watch move.

Perhaps these views are not easy to make quite evident at first, more particularly that part relative to the equatorial or heated current going

faster than the world, and therefore making westerly winds as it gets toward the pole; but it is the explanation given by Herschel and Dové. Dové bases upon it what he calls the "Law of Gyration," and to him is due the credit of having proved, if not detected, this law, by comparing most perseveringly, during the last thirty years, observations from all parts of the world; and he has shown that this law of gyration applies equally to all parts of the world; that it is not peculiar to the Atlantic or the Pacific, or north or south latitudes, but it is the general law throughout the world, exceptions occurring only over or near countries which are covered with snow or ice, or are localities where the sun's rays strike periodically and cause great heat. Such local circumstances interfere with the regular or normal movements of the winds.

From the "Law of Gyration," it is easy to trace the contests and effect of the two principal winds, which are quite different in their character, the one being warm and moist, having a great deal of watery vapour held in it as gas in an *invisible* state. Sometimes this vapour will be chilled or cooled by approach to the polar current near it; perhaps above, perhaps on one side, causing the vapour to become visible in the shape of cloud, or, when more cooled, precipitating it as rain; at other times, it is invisibly retained in the atmosphere.

Everybody may have noticed, when the wind has shifted from south-west to west or north-west, particularly during bad weather, that the first shift to the northward, or from the south even towards the west, is generally accompanied by a sharp squall, a good deal of rain, and perhaps hail, after which the weather clears up. This is the usual course in our latitude.

The circulation of atmospherical currents need not be only horizontal—it may be at an angle with the earth's surface—or even vertical; but the first effect of any cold current impinging upon the warm equatorial, is to cause condensation of its vapours in the shape of cloud, if not rain, hail, or snow. After this first effect, being dry (comparatively), it acts like a sponge; it takes up the rest of the vapour that there may be in the air. There is no longer precipitation, but all the vapour that it can sponge up (as it were) goes away invisibly; and after a short time, there is a clear sky with a polar wind.

Thus, the first effect of the cold air is condensation, and the subsequent effect of the dryness of the air is the sponging up and hiding the vapour (as it were) in itself: dry air from the polar regions being capable of containing a great deal more vapour in an invisible state than the warm air which comes loaded with aqueous vapour from the equatorial regions—loaded, indeed, with nearly as much as it can carry.

The struggle between these currents over various parts of the earth's surface, occasionally causes the circular storms, now usually known by the term Cyclones, or rotatory gales.

Whether so called or named typhoons, tornadoes, hurricanes, or whirl-winds, circular or rotatory, more or less, they all are, not exactly, but in an elliptically curved form, more or less irregular rather than circular. The outline of such a circulation of wind in one locality, say a few hundred miles in area, may be represented by moving a piece of card paper, with arrows to show directions of the wind, across a part of the earth's

surface, as shown on a large map,—the North Atlantic, for example, between England and Newfoundland. The course of the arrows shows how the wind is circulating in that space ; so that, while the wind is at one point westerly, at another it may be easterly,—here southerly, and there northerly: supposing such a piece of card-board to represent a body of air in circular motion, and at the same time moving *bodily* onwards, as these great meteors (for so they may be called) do move,—that is to say, while circulating around their centres, they are also moving onwards across the earth or ocean's surface.

If such a circular paper be moved towards the north-east from near the Gulf Stream, or from the neighbourhood of the West Indies, across the Atlantic (as we know, from ships' logs and collected observations, such rotatory storms do move), the wind will be represented circulating round, while the meteor, or cyclone, travels on bodily towards the north-east. When first touching Ireland the wind would be south-east, but, as it moves on, the wind there becomes south, and afterwards south-west (the air in such a meteor is supposed to be going round, so that there are different winds in different parts, which may be some hundred miles separated). At London such a cyclone might begin with an east wind—which, as it passed on, would become south-east, south, then south-west, west, and then north-west, and north—owing to the polar current driving the meteoric eddy southward again.

The turn or apparent sequence of the winds is, in these cases, what sailors call right-handed, or with the hands of a watch ; but the meteor itself, or the body of air in motion, moves round contrary to the hands of a watch, while the appearance to the eye seems to be the reverse. Take London again for example. Supposing the beginning of the movement is at London, with an easterly or south-east wind, and that it shifts thence to the south, and south-west, and west, and then by north to north-east,—the effect to our eye is that of the wind shifting "right-handed," as we say it does, or "with the sun," but the wind in the cyclone itself has been going round actually in the opposite direction, or against the sun and contrary to the hands of a watch,—which is, perhaps, the best reference for illustration.

In the southern hemisphere there has been some confusion, owing to our seamen always calling this direction right-handed, or with the sun, and the opposite direction left-handed, whether in the southern or northern hemisphere, although when beyond the tropic in the southern hemisphere, and looking towards the sun, he appears to move "left-handed," as sailors call it. In dealing with circular winds of any kind, it is better to refer to the hands of a watch, rather than to the sailors' expressions, "right or left handed," "with the sun," or "against the sun."

There is a very simple rule in connection with these rotatory winds, which is, in the northern hemisphere, when facing the wind, the centre of its circulation is square to your right, and when in the southern, square to your left hand. All the terms, tornado (twisted), typhoon, cyclone, hurricane, and whirlwind, are but different words expressing the same rotatory movement or circulation, of vastly increased strength at times, but not always excessive in force and duration.

We do not usually feel the total circular effect; we only feel part of

it; the wind shifting only from some point to some others, because the whole meteor does not often go over any one place; a part of it goes across in general, and, therefore, places on one side of its centre are affected differently from those on the other side, where the wind will appear to shift differently. It is generally found that cyclones, instead of passing horizontally, or parallel to the earth's surface, are inclined at an angle (more or less acute) with the horizontal plane, and we therefore feel only parts of them; there may be several such circulations passing or following in the same direction, and revolving similarly, like eddies, with their lower surfaces on one side of the circulating meteor only, touching the earth's surface, the other parts circling in the atmosphere above our heads, so that we only feel a part of the change, and not the whole of it.

When the centre passes over any given spot there is a sudden change from one direction completely to the other, with probably a lull between. If only an extreme or limb passes, there is a gradual change through nearly half the compass—and very seldom is there an instance of greater sensible change than this, through about half the compass, excepting when successive storms follow one another and cause complications.

Professor Espy of the United States has written much of importance on this subject, and has put forward what has been by some supposed to be a different theory; but in fact his theory is a corroboration of Dové's, and supports such general views as are here offered. Professor Espy says that in a circular storm the wind blows from all directions towards the centre, and it can be demonstrated mathematically that the consequence of the wind blowing from over large areas, some hundreds of miles in extent, towards a centre, will be a whirl near the centre, and a comparative lull in the centre, which is what actually takes place. You find the strongest point of the whirlwind near the centre, but not in it; and the further you get from it, the more the wind diverges from the circular course. You may see a similar convergence in a trough of water with a hole in the bottom. If you open that hole the water begins to pour out, and the water near the opening which causes the movement moves fastest—the outer part moves more gradually. In air there is a somewhat similar effect, as there must be an elevation of the central part consequent on rarefaction or evaporation, which draws air from all other quarters: or there must be a *compression* consequent on two bodies of air passing each other and twisting the air forcibly between: as you see in a river, when one body of water passes another, a succession of eddies caused by such a lateral pressure of currents passing each other. So it is in the atmosphere, only that there these eddies are much more complicated, various, and extensive, on account of the extreme *elasticity* of the air, which not only yields to pressure, but has always a tendency to expand again greatly afterwards—a resilient elasticity not found in water, which is almost incompressible and inexpansive.

With reference to this subject, I would refer to a printed passage written by myself as far back as 1838. "Are not storms exceptions to the general winds or atmospheric currents, not the causes of them? Some persons have laid too much stress upon such exceptions, and have rather overlooked the general principal features—those of the conditions which

prevail almost constantly. Common winds occur throughout the year, except during short intervals; but hurricanes, or even ordinary storms, are comparatively rare. May not opposing or passing currents cause eddies or whirls on an immense scale in the air, not only horizontal, but inclined to the horizon, or vertical. In laying a ship to during a storm there are other points to be considered besides the veering of the wind, such as the direction of the sea, with or against a current. I never myself witnessed a storm that blew from more than fifteen points of the compass, either successively or by sudden changes. In most, if not all of the storms to which I can bear testimony, currents of air arriving from different directions appeared to succeed each other or combine together. One usually brought the 'dirt,' to use a sailor's phrase, and another cleared it away, driving much of it back again, often with redoubled fury. One of these currents was warm and moist, another cold and dry, comparatively speaking. While one lasted the barometer fell or was stationary; with another it rose. At all places I have visited, or from which I have obtained notices on the subject, the barometer stands high with easterly, and comparatively low with westerly, winds on an average. Northerly winds in the northern hemisphere affect the barometer like southerly winds in the southern hemisphere."

With reference to foretelling weather, I will quote two or three very short passages, also from my own writing. "It should be remembered that the state of the air foretells, rather than shows, present weather (an invaluable fact too often overlooked)." I refer to foretelling weather now, because it is immediately connected with the general law of rotation, or Dové's law of gyration. "The longer the time between the signs and the change foretold by them, the longer such altered weather will last; and, on the contrary, the less the time between a warning and a change, the shorter will be the continuation of such foretold weather. If the barometer has been about its ordinary height, say near thirty inches at the sea-level, and is steady or rising while the thermometer falls and dampness becomes less, north-westerly, northerly, or north-easterly wind, or less wind, may be expected. On the contrary, if a fall takes place with a rising thermometer and increased dampness, wind and rain (or snow) may be expected from the south-eastward, southward, or south-westward. Exceptions to these rules occur when a north-easterly wind with wet (rain or snow) is impending, before which the barometer often rises (on account of the *direction* of the coming wind alone) and deceives persons who from that sign only expect fair weather." "Three things appear to affect the mercury in the barometer:—1. The direction of the wind; the north-east wind tending to raise it the most, the south-west to lower it the most; and wind from points of the compass between them proportionally as they are nearer one or the other extreme points."

What it is that causes these peculiarities immediately connected with the direction of the wind, whether it is entirely owing to the air, the southerly or equatorial wind, becoming lighter from its warmth, or from some electrical condition which is not traced out as yet, is not clearly proved. If connected with electricity, as is probable, we cannot yet deal accurately with it. Here only those facts are admissible which are distinctly verified.

"North-east and south-west may be called the wind's *extreme bearings*." If the wind remain for two or three weeks in either of these quarters, the mercury will remain at its highest or lowest point, the atmosphere appearing steady, with a north-east wind. "The range of difference of height of the mercury due to change of direction *only* from one of these bearings to the other (supposing strength, or force, and moisture to remain the same) amounts in these latitudes to about half an inch, shown by the barometer as read off. 2. The amount, taken by itself, of vapour, moisture, wet, rain, or snow in the wind or current of air (direction and strength remaining the same) seems to cause a change amounting, in an extreme case, to about half an inch; and (3.) the strength or force alone of wind from any quarter (moisture and direction being unchanged) is preceded or foretold by a fall or rise according as the strength will be greater or less, ranging in extreme cases to more than two inches." The barometer is affected to the extent of two inches by the *strength* of the wind, it is affected about half an inch by the quantity of moisture in the air, and perhaps another half-inch by the *direction* only of the wind. As these usually act more or less against each other, and in smaller proportions, the barometer is seldom so greatly affected; and its ordinary changes are not so marked. Such rules have been contracted on the scale of a barometer for the use of fishermen and coasters, in the following manner:

On one side being—	And on the other side—
Rise for N.E^{ly}. N.W.—N.—E. Dry or Less Wind.	Fall for S.W^{ly}. S.E.—S.—W. Wet or More Wind.
Except* Wet from N.E^{d}.	Except* Wet from N.E^{d}.

* (Being the only exception.)

"Allowance should invariably be made for the previous state of the column during some days as well as hours, because its indications may be affected by remote causes or by changes close at hand. Some of these changes may occur at a greater or less distance, influencing neighbouring regions, but not visible to each observer whose barometer feels their effect. There may be heavy rains or violent winds beyond the horizon and the view of an observer, by which his instrument may be affected considerably, though no particular change of weather occurs in his immediate locality." "Sometimes severe weather from an equatorial direction not lasting long may cause no great fall of the barometer, because followed by a duration of wind from polar regions, and at times it may fall with polar winds and fine weather, apparently against these rules, because a continuance of equatorial wind is about to follow. By such changes as these one may be misled, and calamity be the consequence if not thus forewarned."

Reference may again be made here to a useful rule. Supposing that a storm is rising, and that a seaman wishes to know where the greatest strength of wind is. If he *faces* the wind, in northern latitude, the centre of the circulation, or cyclone, will be square to his right; and in the southern hemisphere, if he *faces* the wind, the centre will be square to his left; therefore he knows in which direction to go to avoid that part where the greatest strength is, and must shape his course according to circumstances. He can hardly have a simpler rule. His position with reference to distance from the centre, whether it is near the ship or far off, can be ascertained by watching the falling or rising of the barometer, and the way in which the wind shifts. It only requires a sketch upon paper—a rough figure, with an hour or two's observation of the veering of the wind, to know exactly in which direction to steer, without studying any elaborate rules, which sometimes perplex more than they assist the seaman in the hour of need.

Before leaving this part of the subject, I would again advert to the excellence of the Aneroid as a *weather-glass*, if well made. Compensation for heat or cold has lately been introduced by efficient mechanism. In its improved condition, when the cost may be about 5*l.*, it is fit for measuring heights as far as 5,000 feet with approximate accuracy; but even at the price of 3*l.*, as a *weather*-glass only, it is exceedingly valuable, because it can be carried anywhere; and, if now and then compared with a good barometer, it may be relied on thoroughly. There is a place at the back with a screw-head, which may require to be touched occasionally, to reset the instrument, if out of adjustment. I have had one in constant use for ten years, and it appears to be as good now as at first. For a ship, considering the concussion by the fire of guns, for use in boats, to put in a drawer or on a table, I believe there is nothing better for a common "weather-glass."

The dryness or moisture of the air should be noticed in connexion with foretelling weather; "for ascertaining which the readiest and surest method is the comparison of two thermometers, one being dry and the other *just* moistened, and kept so. Cooled by evaporation, as much as the state of the air admits, the wet, or rather the moist bulb thermometer shows a lower temperature, nearly equal to that of the other, when the atmosphere is extremely damp or moist; but lower at other times, in proportion to the dryness of the air and consequent evaporation, even to a difference of twelve or fifteen degrees in this climate during the heat of summer, and twenty degrees or more elsewhere." I have heard of 25° difference in Australia, and parts of Africa, between two such thermometers. From three to seven or eight is usual in England, and six or seven is considered a healthy difference for rooms in which people are living. The two thermometers need not be connected by one frame; but they should be suspended near each other, and in similar circumstances as to shade, and exposure, whether to air or radiation of heat from any substance within a short distance.

Much has been said, during the last few years, about what are usually called "atmospheric waves," to which I would again refer. If wind veer round the compass, in the course of two or three days (more or less), or is many days in making a circuit—invariably, as it goes round, the barometer

rises or falls according to the direction of the wind. Supposing a diagram to represent 36 hours, and divided into spaces of three hours each along the upper horizontal line; while below, points of the compass are shown, from north around by east to north again, and continued to south; and at the side a scale of inches and decimals, from 28 to 31. We may next suppose that the wind has gone round the compass once, or say once and a-half, as happens occasionally; and that it has been an extreme case of depression, as in a storm. Then, if from 30·3, with the wind at north, a shifting occurs, first towards the north-east, and then onward in the same direction around the compass—as the wind so shifts to the north-east, and is about to shift towards the east and south, the barometer foretells it, or falls beforehand. When the wind is north-east the mercury is lower, probably, than when it was at north. As it gets to the east the mercury falls, and gets lower still at south-east, and falls still more to south and south-west, where it is probably the lowest, because it feels the effects of the south-westerly or equatorial current most then, and may be down, let us suppose, to 28·2 inches. As the wind shifts round to south-west, west, north-west, the column in the tube rises, till, perhaps, the wind is north, or even north-east, when it may be as high as 30·8. It has been known in this country as high as 30·9. As the wind goes round again to the east, and south-east, and south, the barometer falls as before, and a line or curve traced upon paper, representing these falls and rises, or oscillations of the barometer, during a certain time, say these 36 hours, has an appearance like the outline of a wave of water; but as these apparent waves, or undulations, take place *exactly* as the wind shifts, and proportionally to its strength—and as, if the wind remains in one quarter for some days, or say two or three weeks together, the curve becomes almost a direct line, remaining at about the same elevation, it seems that there is an intimate and immediate connection between such a curve, or wave line, and the oscillation of the mercury, though not necessarily between the curve and any undulatory movement of the atmosphere above our heads. If a body of the atmosphere above us swelled upwards, like a wave, and fell again, as some suppose, as it were in "crests" and "troughs," how should we reconcile it with the fact of there being various currents passing over each other in the atmosphere in various directions? Aeronauts who have been up in balloons know that from one stratum of air they passed into another, and another, and perhaps a fourth also, moving in different directions. There cannot be *vacancies* between the undulations of various strata of air. These different bodies of atmosphere could not be undulating like waves while having spaces between them, and interferences of cross movements. Waves of ocean have only elastic air above them, which does not impede their rise and fall materially; and they are only superficial.

The effect of such a raising of any part of the mass of air would be that the lighter or equatorial portions, or winds, would rise the highest, and would expand; but, according to the "Wave Theory" (here controverted), the reverse is the fact; you have the lowest part of the apparent trough of the wave, with the lowest barometer, that is, with the air, which is the *lightest* and most *expanded*, and ought (therefore) to rise up the *highest*; and you have, coincident with the heavy dry air, the highest

part, or what is called the "crest," of the wave. Considering then these facts, and the exact correspondence of the movements of the mercury with the wind's direction, besides noticing the extreme variability traceable in such an atmospheric wave, (which can hardly be conceived to be motionless for weeks, as in the case of a steady north-easterly wind, and then going into extraordinary irregularity during a day or two,) we are led to the belief and assertion that what are commonly called "atmospheric waves" are rather delusive; that there are waves in any line indicating oscillations of the barometer, but not traceable in the atmosphere itself, as usually understood by "trough" and "crest" outlines.

Before referring very briefly to the effect of winds upon our own climate generally, I would allude to a few considerations connected with the ocean. It may not perhaps be generally known that over the ocean, in most parts of the world, the average temperature of its superficial water is nearly that of the air near its surface. In the tropics, the temperature of the sea water ranges from 70° to 80° or more, and the air is much the same. In some limited parts of the world the surface water is as warm as 86°, for instance, near the Galapagos Islands; and in some very confined localities, even *more than* 90°, as, for example, in parts of the Red Sea and Indian Archipelago. But, although so warm on the surface, it is very much colder at a few hundred fathoms below, the cold increasing to perhaps 35°. It was long considered that 39° must be the greatest cold that could be found in the lower ocean, being nearly that at which water is condensed; but reliable observations, during the last few years, have shown temperatures apparently as low as 35°. The effect of this great variation of temperature, and therefore in quality of water, or the varying state of the water itself, the action of the winds upon the surface, also of evaporation, of rain, and lunar action, combine to cause constant movement analogous to, if not a circulation of the ocean, like that of the atmosphere, though on a much more limited scale, and perhaps not sensibly affecting very great depths. There is, for instance, the well-known current called the Gulf Stream, which runs from the Floridas across the Atlantic towards Europe, with a temperature ranging from 80° to 60°, and underneath which there is a current which several observers, including Captain Cochrane, have found to be as low in temperature as 36°, or less. Off the Cape of Good Hope there is a similar remarkable mixture of extremes of temperature within a very short distance of each other. The Lagulhas stream, running from near Madagascar, by the coast of Africa and the Cape of Good Hope, has a temperature of 70°; but near the Cape meets with cold water from the Antarctic regions, at a temperature ranging from 40° to 50°; and these currents occasionally intermingle, sometimes near the surface, sometimes below it, so that one may dip a thermometer in the water at one hour, and find 45° or 46°, and an hour or two afterwards find from 65° to 70°. Similar places occur in the Pacific Ocean, and one very marked, near the Galapagos Islands, on the north-west and south-east sides of the group.

The effect of such warmth of sea-water, particularly that of the Gulf Stream, upon our own climate, and the waters that are near the shores of other countries upon land adjacent to them, need hardly be referred to even in passing, except to remark that wind blowing over a body of

warm sea-water is warmed and otherwise affected perhaps chemically.* Those countries which are exposed to the sea-winds of the lower and middle latitudes all round the world, in the northern as well as in the southern hemisphere, bringing moisture and warmth with them, are milder in climate and more favourable to vegetation than those countries which are exposed to dry land winds, whether hot or cold. Tropical, or other east winds, from over an expanse of ocean, carry vapours and rain. But they differ in some respects from the westerly. Polar currents in general carry but little moisture, excepting where they have passed over, immediately before reaching the land, a considerable expanse of ocean, whence they have taken up evaporated moisture, and therefore acquired a character more like that of ordinary sea winds, though not so moist and beneficial in nature. Generally speaking, sea winds are more or less charged with vapour, but land winds are usually dry and very different in their qualities, according to the country traversed.

It has been much discussed in Scotland within the last two or three years whether the Gulf Stream has really so much effect upon our climate as has been usually thought, and it has been chiefly questioned because experiments have been made with thermometers close in-shore, within twenty or thirty fathoms, where the water has been affected more or less by rivers, or the land near it, and has not been found nearly so warm as the winds or water of the Atlantic—but this seems to be rather a fallacious ground of argument. There is no doubt that along the coast of Norway, as well as the coasts of Scotland and the Hebrides, the warming effect is such that all ice is kept out of the harbours there. The climate is mild all the year round, even at the North Cape; while on the western, or the opposite side of the Atlantic, ice comes down in-shore to a very much lower latitude, even below Newfoundland.

The Consul-General for Norway (J. R. Crowe, Esq. now in London) says, that within the last few hundred years ice has increased along the east coast of Greenland very much, according to authentic records which he has consulted. There were colonies, several centuries ago, on the east shore of Greenland, then an open coast, which were destroyed by being blocked up by ice, and have never been heard of since.

The space between Iceland and Greenland is now blocked up entirely, although some centuries ago it was quite open; while between Iceland and Nova Zembla there is still a very large space of open water, and for 200 miles round the Naze, or North Cape of Norway, *no ice is ever seen.* The Gulf Stream is found to communicate its effects across the Atlantic by more or less narrow streams, or threads, of warm water, even to the eastward of North Cape, where none of the harbours are frozen up throughout the year, and where fishermen work in lighter clothes than they use further to the southward.

In some countries, where the wind blows almost constantly in one direction, vegetation is abundant on the side against which the wind blows from the ocean, an inexhaustible source of moisture, while on the other side there is scarcely any vegetation at all; as in Peru, Patagonia, parts of Arabia and Africa, various islands, parts of Asia and of Australia, where all the moisture from the sea winds has been condensed and

* *e.g.* Ozone.

extracted; and in passing across extensive land, the other sea-side, as in Peru, receives only dried air from the land, and the country is more or less barren. So in many other places, wind carrying moisture affects one side of a hill or mountain, and does not affect the other equally. Our own climate being exposed to south-westerly, westerly, and southerly winds for about three-fourths of the year, is remarkably favoured in this respect, as these winds are not only moist, but warmed in passing over the warm waters of the ocean, both tropical, and of the more expanded part of the Gulf Stream.

There can be no fear of any material change in our climate under such peculiar circumstances, but it may be very questionable how far the northern regions,—those in the latitude of Iceland and from Newfoundland across to Norway,—how far these countries may be affected by the increase or diminution of ice in the Arctic regions; and this is a question which may also have its weight with reference to our own seasons.

The temperatures of the depths of the ocean have been ascertained by thermometers peculiarly constructed, self-registering, and showing maximum as well as *minimum* temperatures, or minimum only, which is probably sufficient, and admits of the instrument being *narrower*, a considerable advantage in *sounding*. Such instruments must be strong enough to resist the pressure of the ocean at two or three miles depth, where there may be a force exerted to compress them, exceeding two hundred, perhaps three hundred, atmospheres (of 15 lbs. to the square inch).

The specific gravity of the ocean has been tried lately, in nearly all parts of the world, by small glass hydrometers; and the general result is that the specific gravity of the salt water is very much the same in all places, except where affected by recent heavy rains, or by water from the mouths of large rivers ; the differences in the specific gravity being found to be less usually than the common errors of observation with the hydrometer, which may occur if it is put into water without being carefully wiped. From the mere carelessness of not thus cleaning it, a difference of two or three divisions of the scale may be caused. The instrument is however *very accurate if correctly used.*

The general result seems to be established that the ocean is almost everywhere at the surface within one or two divisions of 1,027 (calling distilled water 1,000 grains), the sea-water averaging 1,027 grains in weight. The difference between various parts of the ocean, taking the whole world, being not more than 2 or 3 of these divisions from 1,027, or from 26, in short, to about 28, which is, as I said, rather less than the difference between using the instrument carelessly and accurately. In the Red Sea a specific gravity considerably higher than 1,028 is said to have been found; and some of the eastern seas show similar exceptional instances (*said* to extend to 1,080 in the Red Sea.)

Interest has been caused lately by what is called Ozone, which has been thought to affect health considerably. Whatever may be the real chemical or philosophical explanation, the known facts at present appear to be that ozone is chiefly found on or near the sea, and that winds which blow towards the land from the nearest sea bring the most ozone. Lieutenant Chimmo has lately observed that in the Hebrides, and on the north-west coast of Scotland, there is more ozone than he found in other

places, including the great ocean, and, on comparing notes from different parts of our own coasts, it is remarkable that the wind which accompanies the greatest indications of ozone is that which blows from the nearest and largest sea. When Mr. Jansen, of Holland, and Dr. Mitchell, of Edinburgh, made observations in India, in the Atlantic, and in Algeria —Mr. Jansen's being between Batavia and England—they found, by independent methods, that over the sea, clear of the land, there was most ozone, and that over land or hills near the sea—hills against which the sea-winds blew—there was more than in the valleys or in other places which were separated from the sea, and that inland, about towns, and in inland places generally, there was exceedingly little.

This seems to point to a connection between ozone and chlorine gas, which is in and over sea-water, and which *must* be brought by any wind that blows from the sea. I will not here make any further reference to its peculiarities, except one—its possible affection of the gastric juice—as it is a rather too purely chemical question. I will only repeat, that at present the results of various different observations of ozone show that the greater prevalence of it is with wind that blows from the nearest sea; and that it prevails more over the ocean and near it than over land, especially land remote from sea.

It is intended in the course of the next twelve months to endeavour to obtain simultaneous observations of wind, weather, and other meteorological information, over the whole Atlantic, and round the coasts of this ocean, by enlisting the aid of observers in every quarter, for one or two observations only, in each day; with a view of getting at the exact state of each portion of the atmosphere, over our nearest ocean, during one particular time, on certain days, and then mutually comparing those successive and synoptic *views*, as it were, of the atmosphere, in order to discover the usual or normal sequence or succession of winds and weather, as more particularly affecting seamen and agriculturists. A memorandum has been circulated, and instruments specially suited have been lately forwarded to Halifax, Bermuda, and other places. The following extracts are from that memorandum :—

"The Royal Society and British Association for the Advancement of Science, having made official application to Government in favour of the establishment of anemometers at certain selected stations, the Meteorological Department of the Board of Trade and Admiralty has prepared two such instruments, and arranged for their conveyance to Halifax and Bermuda. It is proposed to request the principal authorities at each place to give aid in placing the anemometer and arranging for careful attention to it once a-day during the limited period of intended investigation of atmospheric laws throughout the Atlantic ocean.

"This period will commence at Midsummer next, and continue uninterruptedly until the following midsummer. During this interval of twelve months a collection of meteorological information will be sought from every part of the Atlantic Ocean—from ships, and from observers on its coasts and islands.

"It seems only necessary to state the object in view, and how the undertaking originated and is supported, to ensure hearty co-operation."

The scientific questions at issue that will derive so much advantage

from the great collection of observations that is now being made in America, France, Holland, and this country, should not be allowed to extend indefinitely, lest the data should grow overwhelming. Up to the present time the practical results, as far as navigation, and what one may call "weather wisdom," are concerned, are satisfactory. On board ships, attention to signs of the weather, to winds and currents, and magnetism,—and consequent avoidance of accidents, besides saving life,—have been remarkable.

On our own coasts there is now, in almost every fishing village, some kind of barometer, and attention is paid to its signs of weather. Fishermen do not often now go out at hazard, but watch the instrument and the sky, and judge for themselves. If practical results of meteorological investigation can be turned to account even thus in the present day, besides gathering materials for scientific men hereafter, those who co-operate is the work must have reason for conscientious satisfaction, which indeed in their highest reward.

CHAIRMAN.—The elaborate and instructive lecture which Admiral FitzRoy has given us has been listened to with the greatest interest and attention. Seeing the beneficial results that have followed already from such labours, I have no doubt that at some future day, when further carried out, not only many ships, but very numerous lives, will have been saved, in addition to all the commercial and purely scientific advantages derived. I beg to call upon you now to join me in a vote of thanks to Admiral FitzRoy for his lecture.

The motion was carried unanimously.

Tuesday, March 29.

Colonel the Hon. J. LINDSAY in the Chair.

THE VALLEY OF THE YANG-TSE-KEANG, BEFORE AND SINCE THE INROADS OF THE REBELS, AS FAR AS THE COMMERCIAL MART OF HANKOW: Partly from Personal Observations.

By Sir John F. Davis, Bart. K.C.B. Member of the United Service Institution.

The Keang, or Great River of China, has been laid open by the Treaty of Tien-tsin up to the central mart of Hankow, a distance of more than 500 miles from its mouth below Nanking. Having myself journeyed along 300 miles of that distance, from the extremity of the Grand Canal to the Poyang Lake, I purpose to state the results of my own observations to that extent, and to supply the rest from the experience of others. The fruits of Lord Elgin's adventurous and most interesting expedition are now before us, and I purpose to introduce these by a condensed summary of what has been known before, and then proceed to institute a comparison between the former and present states of the country (before and since the devastations of the rebels), as the ground of our just anticipations for the future.

The whole tract in question lies, with little exception, between thirty and thirty-two degrees of north latitude, the favoured climate of tea and silk, our principal imports, and including some of the finest portions of China. Commencing by the mouth or delta of the river, we have the long alluvial island of Tsoong-ming, about thirty miles in length, and called from its shape and position *Keang-shĕ*, the "tongue of the river." A small party landed here during our first war and lost an officer, whence that spot at the west end was called Harvey Point. Its principal town, *Tsoong-ming-Hien*, on the south coast, is only a town of the third class. The canals with which the island abounds have high embankments to preserve the country from floods, especially dangerous from the low, flat, and alluvial formation of the land. The dense population has resulted as the effect of Chinese industry exerted on a naturally fertile soil. The portion least cultivated is the north side, abounding in those coarse high reeds which are found on the low shores or islands of the river higher up, and which serve, in combination with mud, to form embankments and even dwellings, as well as occasionally answering the purposes of fuel. A portion of the soil in the northern part is so saturated with sea salt as to form a fund for the supply of the whole island, with a large surplus

for the main land itself.* The southern portion is the most fertile and cultivated division of the island, producing rice, wheat, barley, and millet.

From the western extremity of Tsoong-ming to Chin-keang on the Grand Canal, which is the first point of much interest on the river, the total distance, with windings, is about 125 miles. That so long a tract should be comparatively destitute of large towns,† is explained by the fact, that the government, aware of the accessibility of Nanking and the Grand Canal from the sea, has always discouraged the navigation below Chin-keang, the canal itself supplying an inland transit independent of the sea-coast. This portion of the river was an unknown mystery until Admiral Sir William Parker in 1842 conducted seventy men-of-war or transports to Nanking without the loss of a vessel, where no European keel had ever ploughed before. This, and the late expedition of five war steamers all the way to Hankow, in spite of difficulties generally deemed insurmountable, are exploits of which our navy may justly be proud. I have known many instances in the far East where they have had the good fortune to succour foreign ships in trouble; and I cannot call to mind any occasion on which they have had to claim foreign aid themselves.

It is at Chin-keang that my own acquaintance with the great river begins, and continues to the Poyang Lake, about 150 miles short of our treaty limit at Hankow. Journeying in the boats of the country, the difficulties of the passage to a large squadron of Chinese vessels, against the stream and a contrary wind, occupied no less a time than from the 19th of October to the 14th of November, or little more than ten miles a day, leaving abundance of time for excursions and observation. It conveys some idea of the breadth of the river (when full from two to five miles in breadth) when I state that it frequently afforded a tolerable horizon for ascertaining the latitude.

The neighbourhood of Nanking has become so comparatively familiar to us that we may pass on at once to a higher and less known point, which we reached on the 29th October, namely, Se-leang-Shan, the "western pillar hill," a remarkable high rock, which, with the "eastern pillar hill" on the opposite shore, forms the *Gades* of the Keang, about thirty-five miles above Nanking. From the top of the western rock, a height of 500 feet, we observed the broad channel of the river, as it flows between two lines of mountains to the sea. This is a remarkable spot among the Chinese themselves (in peaceable times); and the well-built town at the foot of the rock seemed to owe its existence to the influx of visitors. On the 30th October, the strength of the stream and the want

* This article is so superabundant as to render its importation from abroad a rather profitless speculation. It was a part of my business in China to decide against its importation, in accordance with the fiscal regulations of the government, with whom it is a very important source of revenue; and I observe that, by the trade regulations appended to Lord Elgin's recent treaty at Tientsin, this decision has been confirmed, by the article of salt being expressly excluded.

† The chief towns which succeed each other on the north bank are Tung-chow, Tsing-keang-Hien, and Tae-yu-Hien; on the south bank are Too-paou-Hien and Yeh-shan-Hien,—all of them towns of the second and third order.

of wind obliged us to stop at Wu-hu, a very considerable town about ten miles above the "pillar rocks," and dependent on Taeping. In proof that the technical classification of Chinese towns does not always indicate their real size and importance, this appeared to be superior to many of their first-class cities; and it is to the great inland commerce carried on by this town that such unusual wealth and prosperity are to be referred. We here first observed bales of cloth with the English mark upon them, about 600 miles from Canton, inland.

Quitting Wu-hu on the 31st October, we started with a north-west wind, and, our course here being sometimes due south, we made more progress than usual, accomplishing a hundred lees, or thirty miles, by the time the boats reached the mouth of a tributary river named *Teih-Keang* on the right bank, in which we anchored, near a small town built at the foot of some low hills. The Emperor's desire to get rid of us by the shortest route was the fortunate occasion of our thus navigating the Keang between the Grand Canal and the Poyang Lake, instead of following the beaten track of low marshes along the remainder of the canal. After travelling through the swamps of Shantung and the north of Keang-nân, we were now in a country that could yield to none in the whole world, and is equalled by very few. It was justly remarked by the late Sir Henry Ellis, one of our party up the Keang, "However absurd the pretensions of the Emperor of China to universal supremacy, it is impossible to travel through his dominions without feeling that he has the finest country within an imperial ring-fence in the world." After the lapse of about a fortnight we were, owing to contrary winds, and the timidity of our boatmen, not advanced one-half of the way to the lake; but this delay only afforded the more time for observation and inland excursions, which met with no opposition from our conductors.

On the 1st November, we advanced only twelve miles, to Tsing-kea-chin, on an island which divides the stream of the Keang, and above which the river spreads to a breadth of nearly five miles, after describing what appeared to us a considerable portion of a circle round two islands. On the 2nd, as early as nine o'clock, we found the whole squadron of boats anchored at the considerable town of *Tung-ling Hien** on the right bank, eighteen miles from Teih-keang. Thinking we were to stop for the day, some of us set out as usual on a ramble through the town into the country beyond, but in the course of an hour the wind became fair and the boats prepared to sail. We had extended our excursion to about two hours, when some Chinese came hallooing and announcing the departure of the fleet, and we did not conclude our chase of the boats on their way, up until four hours after quitting them.

On the morning of the 3rd November we were anchored at a town called *Tatung Chin*, on the right bank, and opposite to those long islands by which the Keang is so often divided. We were detained here by contrary winds for no less than five days, which were spent in exploring those beautiful hills at the foot of which the town lies. Our excursions extended to circuits of fifteen and sixteen miles, when we often came across tea

* The name denotes "copper mountains," and Du Halde speaks of a valuable *green stone* found here, probably malachite, or copper ore

plantations, though here less frequent than in the south-east parts of *Keang-nan*, and in *Chĕ-keang* and *Fokien*.

On the morning of the 7th of November it blew strong from the north-east, and we made one of our best days' journeys, arriving in the afternoon at Woosha-kea, or "Black Sand Fork," *kea* meaning one of those numerous points where the Keang forks out into two branches to compass an island in the middle. As we were about to enter again on the main stream, our conductors thought it prudent to remain until the wind moderated. Nothing was more surprising than the difference between the Chinese sailors of Canton and their "long-shore" brethren of the Keang. The boats were almost as different as the boatmen; for, while the Canton boats are strongly built and capable of buffeting with the waves, these great square boxes, clamped with iron at the joinings, seemed really to justify the apprehensions of their conductors. This difference may partly be ascribed to the habit of occasionally encountering the sea near Canton, and partly to the long experience and example of Europeans at that place.

On our way to the present anchorage we passed the city of Chee-chow on the right bank. Du Halde describes this as having six dependent towns, and, though surrounded by the lofty hills which we observed from the boats, rich in territory and trade. The wind on the 8th being too strong for our clumsy craft and lubberly sailors, we remained at anchor, but early on the morning of the 9th started with a fair breeze, and after traversing about one hundred lees, or thirty miles, anchored on the further or western side of Ganking, an important first-class city. Du Halde describes the position of this large town as very advantageous, and states that a Tartar garrison was kept there for the command of the Keang and the neighbouring lake. We must have passed this on approaching the east side of the city, where 500 men in line made a good appearance. Our examination of the interior and suburbs conveyed a favourable impression of the place, where we found very good porcelain shops, indicating our approach to the neighbourhood of King-te-chin, the chief place of its production.

We left Ganking at an early hour on the morning of the 10th November, and, after the best day's run since entering China, viz., 125 lees, or nearly forty miles, reached a place called Hwa-yuen Chin, or the "flower-garden station," about five miles short of Wangshan Hien, or the left bank. On our way here, we passed Tung-lew Hien, on the right bank, a walled city of the third class, but containing within its extensive enceinte fewer streets than dwellings and gardens. The most populous part of the place was on the outside of the walls, between them and the river. The houses in this part of the country were white-washed, which gave them an European look. Parts of the river, even as high as this, appeared not less than three miles across, and huge porpoises were rolling along near our boats, as they do at sea.

After being detained at Hwa-yuen Chin for a whole day, we sailed on the 12th November, and soon came to a part of the river where it is again divided by a long island into two streams, and, proceeding along the south or right bank, we passed Ma-tung-shan, "Stirrup-iron Hill," a curious bluff point; and towards evening approached a very remarkable

insulated rock, rising precipitously from the stream to the height of 250 feet. This (with another larger one at the entrance of the Poyang Lake) is celebrated in China by the name of Seao-koo-shan, "the Little Solitary, or Orphan, Rock." It appeared inaccessible on all points, except one, and here the Buddhist priests had contrived to erect some of their temples on terraces, rising one above the other. But the most remarkable feature was the countless swarm of pelicans, or fishing cormorants, which darkened the face of the rock by their numbers.

We had now entered the limits of the Keangse province, and the first walled town we passed, by name Peng-tse Hien, was, in point of position, the most remarkable we had seen. It lay on the right bank, nestled in a romantic valley, or rather amphitheatre, formed by the lofty hills around, but open to the river. Among native drawings of remarkable places, I possess one of these, as well as of the "Orphan Rock"—both of them especially noticed in Lord Elgin's expedition.

The weather became thick and boisterous, but we proceeded, and our boat with some difficulty reached Kin-kang-leaou, our destined resting place, being a village of small note at the mouth of a creek on the north or left bank of the river. We passed the 13th also at this anchorage, which the Chinese itinerary stated to be about sixty lees, or some twenty miles, from the mouth of the Poyang Lake. We became naturally anxious to inspect this famous inland sea, which, however, though about seventy miles long, is only the second of the empire in size, and yields greatly to the Tong-ting Lake, also fed by the Keang, but considerably above Hankow.

We set sail early on the 14th November towards the Poyang. On the bold and hilly shore to our left (the right bank), we passed Hu-kow, at the "Lake's Mouth," as the name implies. Here, after little less than a month's protracted journey over a distance, by the Chinese itinerary, of 950 lees, and our own calculation 280 miles, from the canal, we quitted the magnificent Keang to cross the lake on our way towards the south, already 400 miles from its mouth, but yet 2,000 short of its source. The entrance to the lake was about a mile wide, and after passing this we came upon the Takoo-shan, or "Great Solitary Rock," rising out of the waters of the vast lake, and larger than the others, but less picturesque and striking in effect.

For the rest of the route to Hankow, we were indebted (previous to Lord Elgin's Expedition) to Du Halde and M. Huc. The remaining distance from hence is about 157 miles. The first large city is Kew-keang, a few miles past the entrance of the lake, with the lake on its east, and the river on its north side. Du Halde states, from the Jesuits' survey, that the tide is apparent here at new and full moon. He speaks of the porpoises, which we had ourselves observed, and states besides that salmon and sturgeon are caught as high up as this point. After averaging a westward course for about twenty miles to the mouth of a river on the right bank, flowing in from Hing-kwo, the Keang lies north-west and south-east from Hankow, the first city of consequence being Hwang-chow on the left bank. Du Halde observes of this, that its neighbourhood to the great centre of commerce, Hankow, and the lakes and rivers in which the vicinity abounds, naturally render it very commercial and opulent. The country is highly

cultivated, and rendered very picturesque by the hills on the north. Under its jurisdiction are eight towns of the third (Hien), and one of the second order (Chow).

Seventy or eighty miles above this city we reach the important central point where the three great towns of Wuchang, Hanyang, and Hankow, lie at the confluence of the Han-keang with the Yang-tse. This affluent of the great river is in itself no inconsiderable stream, running a course of six or seven hundred miles, including windings. The three great cities form a sort of triangle, separated only by the water from each other. Wuchang is the capital of the double province Hu-kwang (north and south) and the residence of the Governor-General. Du Halde observes, "Voutchang est comme le centre de tout l'empire, et le lieu d'où il est plus aisé de se répandre dans les autres provinces." He adds, that it is "le lieu le plus peuplé, et du plus grand abord de la Chine." To any one who has seen Shanghae, this must seem surprising. It is placed opposite to the confluence of the Hankeang with the Yang-tse. "Doubtless," says Du Halde, "in viewing only this forest of masts, which borders that noble river the Keang, about a league in breadth at such a distance from the sea, there is sufficient ground for admiration; but if on mounting some height one comes to discover that vast tract all covered over with buildings, one scarcely believes one's sight, or at least one believes it to be the finest thing in the world of its kind."

Han-yang, the second city of Hu-kwang, is separated from the above only by the Keang, and lies at the western angle made by the confluence of the Hankeang with the Yang-tse. Hankow, on the opposite angle, is the mere growth of this immense commerce, which, in China, seems often to escape from the municipal trammels of the interior of walled cities, and to fix itself on the outside, in order to breathe more freely.

It is some drawback to the splendid prospect held out to our future trade, to consider that the valley of the Keang, from Chin-keang and Nanking to beyond Hankow, either is now, or has been for years, in the power of the rebels; and that, as their occupation and pursuit have been civil war and rapine instead of trade, the baneful effects must be very perceptible. But every one who has only seen how speedily the Chinese repair the disasters of a fire, may feel sanguine as to the healing results of their indomitable industry:

"Mox reficit rates
Quassas, indocilis pauperiem pati."

The adventurous and most interesting visit of Lord Elgin to Hankow now enables us to judge of the existing state of the Keang and its cities. The Retribution, Furious, and Cruiser war-steamers, and Dove and Lee gun-boats, left Shanghae on the 9th of November. The shifting sands and shoals of the river had completely altered its channels as far as Chin-keang since the survey of 1842, and the squadron did not reach that point under a week, when, as an additional delay, the Furious struck on a sunken rock between the south bank and Silver Island. On the 20th of November they reached the head quarters of the rebels at Nanking. Having been fired on pretty sharply in passing, the wise resolution was

formed to drop down next morning with the stream and administer such a lesson as would prevent the Chinese repeating the aggression on the return of the squadron; and this was done in the completest manner. It must be remarked that the Emperor's fleet, close at hand, was encouraged thereby to make an attack on the rebels' position immediately afterwards, though at a safe distance; a style of warfare which accounts for this civil strife having dragged on in a chronic state for so many years. The condition of the rebels, however, is decidedly retrograde. They have been driven from Chin-keang, which they before occupied on the canal; their floating force has been displaced by the Emperor's war-junks along the whole of the Keang; and the expedition observed that the besieging imperial army formed a complete semicircle about Nanking by land.

The lesson at head-quarters was probably the cause of amicable overtures being made from the rebel city of *Tae-ping* on the right bank; and when our squadron reached *Wu-hu* on the 23rd, after serious detentions by shoals, here again their fame had preceded them, and they were civilly received by the insurgents, whose appearance and condition conveyed anything but a favourable impression of their character and resources.

The present expedition was just one month later in the season than that in which I was a traveller, and the fallen condition of the river obliged the Retribution to remain at *Kew-hien*, literally "old town," some twenty-five miles above Wu-hu, and almost the only place in possession of the Emperor's forces on the south bank, from Nanking to the highest point of rebel occupation towards the lake. Their chief stations are Nanking and Wu-hu on the south, and Ganking on the north.

On the 26th November the expedition reached Ganking, the last post of the rebels to the westward. Being on the north or left bank, and the insurgents having no means of communication across, while the city was actually beleagured by the Imperialists, the proceedings at Nanking and elsewhere were probably unknown, and hence a fire was opened on our expedition, which was soon silenced. The Emperor's force again at this place was encouraged by what took place to attack the rebels after the steamers passed on. These indications have an important bearing on what may be anticipated in the future. They indicate a due appreciation of our power by the Imperial government, and must induce them to have us rather as friends than enemies. The sandbanks again impeded the navigation on approaching the Poyang Lake; thereabouts a few trading junks were for the first time observed, and the expedition was as much struck by the appearance of the "Orphan" or "Solitary Rock" (before described) as we had been so many years previously. After passing the Lake's mouth on the way to Hankow, the city of Kew-keang, on the south bank, was found in a state of complete desolation, though for some time abandoned by the rebels. At *Kechow*, further on, was observed the boldest and finest scenery on the river, which is here contracted within a gorge formed by the mountains on both sides.

It was not until the 6th December that the expedition reached Hankow, little less than a month after quitting Shanghae; but still not much longer than I was myself travelling (under Chinese conduct) only from Chinkeang to the Poyang, about half the distance.

After previous accounts, the actual condition of Hankow was especially

disappointing. Every dwelling and building in the place had been demolished during the previous occupation by the rebels; but still much had been restored. The shops and warehouses in one quarter are stated to have been unusually large and well-furnished, with a surprising supply of English and European goods. The opposite city of Hanyang was still a waste of ruins; but Wuchang, the provincial city on the south shore, appeared in a much better condition, and corresponded more nearly with former accounts, exciting, indeed, considerable admiration in the expedition.

The population had, of course, suffered by the remorseless civil war almost to extinction, and could afford no ground whatever for an estimate of its former numbers. The reception given by the Governor-General of two provinces to Lord Elgin was a very handsome one, promoted to some extent, no doubt, by what had been done to the rebels on the way up; and the people showed the greatest curiosity and desire to trade.

On the 11th December, the expedition quitted Hankow on its return, and, after proceeding about thirty miles, found that the river was rapidly falling. After a week's incessant labour in working the steamers over the shoals, only 130 miles had been accomplished, and, on reaching the bar at the Poyang Lake, not more than eleven feet water remained, the Furious drawing fifteen feet. In fact, seven feet of water had fallen since they went up. Here the Furious and Cruiser were left, while Lord Elgin and suite proceeded in the Dove and Lee to join the Retribution lower down. On the 29th December the three steamers reached Nanking.

The rebels displayed, as might have been expected, a very peaceful disposition after their previous chastisement; and a visit being paid to the rebel chief, the interior of Nanking exhibited the same scene of ruin and desolation as the other places occupied by the rebels, whose sole business seems to be destruction without any reproduction. It was evident they were hard pressed by the Emperor's force, and one of the chiefs made secret proposals to the English party to be allowed to desert his colours. Arrangements were effected for safe communication with the two ships up the river, and the mission reached Shanghae on the 1st January, after more than seven weeks' absence.

It is impossible to anticipate any other than the best results from this well-timed expedition by Lord Elgin. It seems to have tested with success the good intentions of the Peking government, if we may judge from the conduct of their representative, the viceroy of Hu-kwang. But had it produced no other result than to establish a proper understanding with the rebels, and show them the folly of aggressive measures towards our people, this alone was worth having. The court of Peking probably hopes from us something better for itself than perfect neutrality towards the rebels, and may have been confirmed in this hope by what the squadron, in mere self-defence, was compelled to do against them up the river. Should this tend to secure good faith and practical sincerity in the observance of the new Treaty, we may accept the results with satisfaction, without troubling ourselves as to the disinterestedness and purity of the motives. If the authorities are encouraged to strenuous exertion, and put a final end to the rebellion which is desolating the country and paralyzing trade, this will be a great common benefit.

Friday, April 1st.

General Sir JOHN F. BURGOYNE, Bart. G.C.B. in the Chair.

THE RIFLE AND THE SPADE, OR THE FUTURE OF FIELD OPERATIONS.

By Captain TYLER, R.E.

BESIDES other divisions, the art of war may be considered, in a military point of view, under three heads—

1st. The attack of fortresses, or siege operations.

2ndly. The conduct of an army in the field, or field operations.

3rdly. The defence of fortresses, and the modes of construction to be adopted in defensive works.

And there is no question more interesting to military men, or more important to the world in general, at the present day, than that of the effect which the modern rifle may be expected to produce, on these different operations, respectively.

I had the honour of treating "on the influence of the rifle upon siege operations" in this place last year; I propose to-day to consider its probable influence on field operations, to the best of my ability, and as far as time will allow; and I hope to be permitted, on a future occasion, to discuss this question with reference to the third of the above headings.

I make no apology for thus coming forward, although I do so with great deference to many amongst my audience who are much better qualified to speak upon the subject. I think it is of great importance, and that it is the duty of military men, to discuss this question. I believe that, by careful study and reflection, we may, looking from our own point of view, each add our mite to its better understanding; and I know how indulgent an audience of this sort always is, to one who searches earnestly after truth in any field, whether they agree with him in opinion, or whether they do not.

A great deal has been said and written, during the last ten years, at home and abroad, on our subject of to-day; and the discussions that have arisen, though dealing at the same time with other questions involved, have mainly turned upon the relative capabilities of riflemen and field artillery. In our own country, we have had the advantage of seeing this point somewhat warmly contested, and we are therefore the better able to form our conclusions in regard to it.

The disciples of the rifle commence by giving us most formidable results. They tell us that well-trained men, judging their own distances, can shoot with the Enfield rifle accurately at 600 yards, and effectively up to 1,000 yards, or even more upon occasion. They have the Lancaster rifle, which shoots better than the Enfield rifle; the Whitworth rifle, which shoots better still; and Colonel Jacob, himself an artillery officer, informs

us that he has gone so far as to blow up an ammunition waggon with one of his explosive bullets, when shooting from the shoulder, at the astonishing distance of 1,800 yards. Trying their weapons at different-sized targets, made to represent columns of men, or field artillery, or bodies of cavalry, they astonish themselves and others by the results they can produce; and they come to the conclusion that neither cavalry, nor the field artillery, that played such an important part in former wars, will be able to stand against them.

Certain officers of artillery, who naturally do not like to be driven out of the field in this summary manner, give us their side of the question. They tell us that these new rifles may become troublesome to them, but that they will not be so formidable on active service as they appear to be in home practice; that there is not sufficient intelligence in the army to admit of good shooting becoming very general; that, where accurate rifle shooting ends, there the action of spherical case begins; that the artillerymen have a great advantage over the riflemen in watching the action of their shot, and in thus getting their ranges more accurately; and that they fire with greater steadiness. A distinguished officer has stated in this theatre, that "It would be unfortunate if anything should tend to disturb the proper relationship that ought to subsist between the three arms; that no good or decisive results can be anticipated on land or at sea by playing at 'long bowls;' that that infantry or that vessel of war which shrinks not from opening fire against an adversary at ranges of about 400 yards and under, and delivers its fire with the greatest efficiency, coolness, and determination, will come off best; and that, if rapid and decisive results are to be aimed at in future wars, they will only be attained by using the superior arm which our soldiers now possess, at distances not materially varying from those at which they formerly attempted, with inefficient means, to do their duty."

One who has written in the *United Service Journal*, also, under the title of "A Field Officer of Artillery," gives us an interesting little bit of Crimean experience, the truth of which has been amply confirmed from other quarters. He says, "The miserable combat before Sebastopol in this respect, when no man dare stir even to assist a wounded comrade without catching the eye and provoking the skill of some hidden sharpshooter, is not a species of fighting which we would like to see carried out on a larger scale with armies in the field;" and he adds, "that the bold bowmen of Crecy and Agincourt would scarcely appreciate the compliment of being classed by Colonel Jacob with men whose courage is to be displayed by their skill in destroying an enemy with a minimum amount of danger to themselves."

The Commandant at Hythe replies to some of these arguments in his official Report for the year ending March, 1857. He gives us a measure of the capabilities and intelligence of those with whom he had to deal during the previous year, by telling us that 61·11 per cent. of the officers instructed, and 55·29 per cent. of the men, attained to the first of three classes in shooting; while 84 per cent. of the officers, and 79 per cent. of the men, ranked in the first class in judging distances. And he adds, "I am quite satisfied from what I have seen, that the private soldiers of the Infantry generally are quite intelligent enough to acquire a sufficient

knowledge, theoretically and practically, in the use of their rifle, so as to render them more than a match for any field artillery at present in existence."

Such is the nature of the discussion that has been carried on, and I am sorry my time will not allow of my referring to it more at length. Since it has taken place, the powers of Sir William Armstrong's gun have been brought to light, and they have given us a foretaste of what we are now to expect from rifled artillery. The principles advocated by Mr. Whitworth in regard to the rifling of guns, promise at least as well as those which have been so successfully adopted by Sir William Armstrong; but the latter has succeeded in introducing a system of loading at the breech; and his fuze and projectiles have hitherto distanced all competitors. We may hope that these gentlemen, and others perhaps also, will make rapid progress in bringing rifled artillery to greater perfection, now that so important a start has been obtained. Rifled guns will, however, be even more valuable in consequence of their increased precision at ranges of from 1,000 to 3,000 yards, and of their lower and more equable trajectory, than on account of the still greater ranges that may be obtained from them.

This increased range and accuracy will be of immense importance on occasions where such qualities are required; but will not so much assist artillery, even when such weapons as the Armstrong shells are employed, in its action against wholly or partially concealed skirmishers, extended along its front and around its flanks. In the field, particularly, where it is very desirable not to waste artillery ammunition on fruitless objects, it would be unwise to make use of these projectiles against men so posted; and, indeed, in hardly any case would their great powers be profitably employed in a contest with *extended* skirmishers at the present distant musketry ranges. Let us proceed to look a little more closely into the subject.

We must admit, in the first place, that small-arm practice in the field will be less accurate than similar practice at a painted target. The weapon, indeed, will be the same, and its range will be as formidable, but the dust, turmoil, smoke, and excitement of the battle-field will detract from the accurate aim of the men; and irregularities of the ground will much interfere with extreme ranges. We cannot suppose, however, that the British soldier,—who has hitherto been so remarkable for his steadiness under fire,—whose cool behaviour in line, against dense advancing columns, produced in the Peninsula, as Sir William Napier says, the most destructive fire ever known,—who, when acting with the inferior weapons of former days, against the previously invincible veterans of Napoleon, reserved his fire until his enemy came within thirty or forty yards of him, and then delivered the fatal volley which was so ominous a precursor of his determined charge; we cannot suppose, I say, that this British soldier will now knock his knees together, and lose his presence of mind, because he can fire, and be fired at, at longer ranges. It is certain, on the contrary, that the better his weapon, the more he is instructed and practised in the use of it, and the more confidence he acquires in his own powers,—the more likely he will be to retain his wonted self-possession, and to employ his ammunition in a useful manner.

Our instruction system has not yet been satisfactorily tested. When it is so, it is probable that the rifle advocates may be somewhat disappointed in the first instance with the performances even of their best regiments; but it is equally probable that all their reasonable expectations will be fully verified by the performances of veteran troops. Old soldiers, with greater experience, and increased fertility of resource, will, like those hidden Russian sharpshooters before Sebastopol, referred to by the author whom I have quoted, do much in furtherance of that "miserable" species of combat which he so deprecates, and will render life at least uncertain to all those of the hostile forces who are placed uncovered within their reach.

Making liberal allowance for a difference between home and service practice, it is quite clear that our riflemen, who can shoot accurately at 600 yards, and very effectively against large bodies at half a mile, will never be restricted to a range of 400 yards; and it is certain that the improvement of infantry practice in the field will bear some considerable proportion to that which it has made elsewhere. Smoke, and other impediments to aim, will no more disturb the infantry than the artillery. Irregularities of ground, which prevent cavalry or artillery from acting, will favour the operations of infantry skirmishers; whose long ranges, from slightly elevated positions, or from different parts of a hill-side in a broken country, will tell fearfully on their opponent's masses.

Under these circumstances, it is evident that no bodies of cavalry, artillery, or infantry, will in future be safe when they are exposed to the fire of infantry skirmishers armed with the Enfield rifle, or one equal to it, at half a mile; and there seems to be no difficulty, as far as weapons are concerned, in providing our soldiers with rifles that will take effect at much greater distances.

I must next proceed to consider what are the actual, and what the expected, powers of artillery, as compared with the newly-acquired capabilities of this terrible infantry.

Artillery has been truly said to be the chief representative of distant combat, or, in other words, of the "long bowls" that have been so much objected to. Its main duties on the battle-field are to fire, either offensively or defensively, at the enemy's troops—to ruin any defences which they may possess—to cover the deployment, the advance, or the retreat, of cavalry or infantry. It is also the duty of artillery, in some cases, to harass, or, if possible, to silence, the fire of any hostile batteries found to be particularly mischievous, either by direct fire, or, what is better, when it can be effected, by horse artillery acting on their flanks.

The projectiles which have been hitherto employed by artillery are grape, common case or canister, spherical case, shot, and shell.

Grape and common case, consisting of balls secured round a spindle, and balls contained in a tin canister, respectively, and known in French by the common name of "mitraille," are exceedingly destructive at ranges of from 150 to 300 yards; but the balls scatter so widely, that it ceases to be worth while to employ them in the field at ranges greater than 300 or 400 yards.

Spherical case, or Shrapnel, so called from Sir Henry Shrapnel, their inventor, are composed of shells filled with musket balls, and containing a

small charge of powder. The shells are made so thin as to burst with a minimum charge, not dispersing their contents more than can be avoided; but sufficiently thick to resist the force of the explosion by which they are discharged from the piece. In order to produce a good effect, they should burst at a proper elevation, and some 50 or 60 yards in front of the object aimed at. Their ordinary range in the field is from 650 to 1,050 yards; but they are somewhat uncertain in their effects, owing to the difficulty of causing them to burst just in the right place.

Extensive experiments were made at Woolwich in the year 1819, and the result of them is given in the little Hand-Book of Field Artillery, edited by Col. Lefroy, R.A. and published in 1854. There were 1,090 rounds fired altogether; from 3-, 6-, 9-, 12-, 24-pounder guns, an 8-inch howitzer, and a 68-pounder carronade, at ranges varying from 650 to 1,100 yards; and from 12- and 24-pounder howitzers fired at ranges varying from 650 to 1,200 yards. Eighty-three per cent. of the shells took effect, ten per cent. not bursting at all, and seven per cent. bursting at the muzzle. The effect upon the targets was not very encouraging. These were composed of two screens, each 54 feet long and 9 feet high; and one of them was 50 yards behind the other. They were struck by only 35 per cent. of balls, including the splinters of the shells; and, as 30 per cent. of those did not penetrate the targets, it is concluded that they would not have inflicted fatal wounds. The moral effect of spherical case, and of artillery generally, is no doubt considerable; and there have been instances, one of which is quoted by Sir Howard Douglas, in which a fortunate shot with spherical case has proved exceedingly destructive; but the material effects of these missiles is, as I have said, uncertain, and they are expensive to use; and these are the reasons, probably, why they have not been more employed by other nations.

Some ingenious improvements have been made in these shells, as many of my audience are no doubt aware, by Captain Boxer of the Royal Artillery. His fuze, a model of which, from this excellent Museum, is on the table, is more easily applied, and more certain in its effects, than the old one; and a wrought-iron diaphragm, which has been cast inside the shell at his suggestion, is intended to be of use in preventing the powder from being ignited prematurely by the friction of the balls contained in it. The necessity for this latter invention has not, however, been universally admitted; and it does not appear that all the improvement that could be desired has thus actually been effected in the practice of spherical case.

Missiles of an analogous nature, but of a superior character, have been constructed by Sir William Armstrong, and are said to have answered exceedingly well; but there is this difficulty in the application of all such projectiles in the field, that they are required, as I have already stated, to burst at a certain elevation above, and at a given distance in front of, the object aimed at, in order to produce satisfactory results. If the shell bursts too soon the balls are too much, if too late they are not sufficiently, scattered. In order that they may be usefully employed, the range must be acquired with considerable accuracy; and this can only be done, when it has not been previously ascertained, either by the ordinary

means of judging or calculating distance, or else by watching their effects, and adjusting the elevation of the gun, and the time for the fuze, accordingly. At long ranges, or against moving objects, it becomes a difficult matter thus to acquire the range at the moment when it is wanted; and it is not worth while to expend ammunition in this manner, when a greater amount of destructive effect can be produced by solid shot, or by shells not intended to burst. At the same time, the improved case will be very valuable against masses of troops, or the defenders of entrenchments, at long ranges, (when opportunity is afforded for acquiring an accurate idea of the range, either by previous knowledge or by watching the effects of the shells,) up to that point at which the velocity of the contained missiles, after the bursting of the shells, is sufficient to impart to them destructive effects.

The argument hitherto employed on both sides, has been, whether field artillery, with its appliances of grape, common case, and spherical case, can stand its ground against infantry sharpshooters. In considering this question with reference to the means in use up to the present time, it would appear, that, as far as grape and common case are concerned, their random effect, at 500 or 600 yards, against a concentrated and accurate fire of rifle-bullets, and perhaps of explosive rifle-shells, would be practically useless. Shot and shell, or spherical case, at similar, or greater distances, could not do much more against an extended line of skirmishers. The position of many of these would be discovered only by the smoke issuing from their rifles. Some of them would probably be acting on those tender points, the flanks of the guns; and their fire could only be partially subdued, even by the aid of any infantry skirmishers who might be spared specially for the protection of the artillery, or who might be acting with them. It is, of course, assumed that such skirmishers will not expose themselves in swarms to the fire of the artillery. When they are foolish enough to do so, they will no doubt suffer for it; but so long as they adopt the more rational system of extension and concealment, they will afford any uncovered gunners that may be within their reach but little chance against them.

These are highly important questions; but there is a still stronger reason why the grape, canister, and spherical case of field artillery at present employed, should lose ground in the field in future warfare. They were more especially formidable and useful when musketry fire was only available up to 200 yards; but they have now been partially superseded, and it would be unwise to continue to make use, to the same extent, of these more expensive, more cumbrous means of field artillery, when the infantry man with his rifle can in some respects do the work better. It is a question whether the Enfield rifle in the hands of the infantry is not now capable of making a greater proportion of destructive hits between 600 and 1100 yards on a column of men than the artillery with their spherical case; and the infantry might be armed, as we know, with rifles that would enable them to do still more at greater distances, if it were thought desirable so to arm them.

The tables here shown, for which I am indebted to Captain Lempriere, the Instructor of Musketry for the Royal Engineers, give some of

the results of rifle practice. No. 1* conveys statistical information relating to the Hythe practice, and gives the best average performances of individuals and parties under instruction at that establishment. No. 2* shows the per-centage of hits made by the duty men of the Royal Engineers, who practised at Chatham during the past year, for different distances, between 100 and 900 yards. The per-centage of the whole practice is represented by the number 42, while 30 per cent. of hits were made between 600 and 900 yards. It must be remembered that the targets here used were very much smaller than those to which I have previously referred, as having been employed in spherical case practice. They vary in size from 6 feet high by 2 feet wide at 100 yards, up to 16 feet wide by 6 feet high at 900 yards; whereas the artillery targets were four times as long and half as high again—54 feet wide by 9 feet high, and there was one 50 yards behind the other. The riflemen would make, probably, but a small proportion of misses in firing at such targets as those last mentioned.

But further information is required upon these points; and it would be exceedingly desirable to have a trial of skill, under fair conditions, between riflemen and field artillery. They should fire under similar circumstances at similar targets; they should each employ the best means that modern science has placed at their disposal; and the proportionate capabilities and expenditure of the two arms, as deduced from the results of such experiments, would then form a useful guide for determining the relative extent to which, and circumstances under which, they might for the future be usefully employed.

Common case and grape may still be useful for certain purposes, such as the defence of defiles and the ditches of fortified works, and for assisting the action of infantry, when the guns are under cover, at short ranges; and the Armstrong projectiles will no doubt have a more extended application; but, as far as appears at present, further improvements in artillery are hardly likely to restore to these descriptions of projectiles *all* the ground which they have lost. Artillery improvement is moving forward in a different direction. The application to large guns of the principles which have proved so efficacious with the rifled musket, will ensure greater accuracy of practice and increasing ranges to the artillery; and the system of employing aggregated quantities of small random projectiles, for which increased precision, beyond a certain point, is of less value, with a view to their producing chance results by their dispersion, is, in effect, giving way, to a certain extent, before improved conditions, under which, with more accurate weapons, better effects can in many cases be more economically achieved.

Unfortunately, the feeling appears to have been too much entertained in previous discussions of this question, either that field artillery must hold its own against the rifle, or else that the artillery service generally must decline before the progress of that weapon. Having pointed out on the one hand, why the artillery have been in some measure displaced from one set of duties, I would therefore explain how, on the other hand, the balance is restored by other work being provided for them; and how, in fact, there will only be an alteration in, and not at all events a diminution of, their important functions.

* *Vide* infra, pp. 193-4.

In the first place, artillery, and an ample force of improved artillery, will be more than ever required in the field for the attack of posts and positions. When hamlets, country seats, villages, or farms are rendered properly defensible, and when the rifle is judiciously employed for their protection, an assault by daylight, difficult under any circumstances, will now become still more so without a well-sustained fire of artillery. In the prosecution of future sieges, an ample supply of artillery, and improved artillery too, will be required to assist on the part of the attack, in counteracting the advantages which the defence has acquired from the use of the rifled musket. Looking to our national position, and the progress of steam in foreign navies, we shall want guns and gunners in greater numbers for the defence of our coasts. And, lastly, referring to a point which I shall presently introduce to your notice—viz. that the employment of the rifle will lead necessarily to the increased use of entrenchments in field operations—I may here add, that there will be required a plentiful supply of shot and shell fired horizontally to ruin such entrenchments, and of shell and case fired at high angles to drive the defenders from their works; and that without these means, an attack upon such works by day can hardly, under ordinary circumstances, be expected to succeed.

The importance of artillery generally, also, will be much increased by the possession of such guns as are now being provided for them.

As the duties of the artillery will thus necessarily be modified, and as they will be called upon in future, when employed to the best advantage, to act more against standing works, and less against moving masses of men at short ranges, so also they will manœuvre in a somewhat different manner. They will be more stationary than heretofore, and will be better enabled to take advantage of a judicious combination of natural position and artificial protection, to secure them from the effects of their opponents' rifle fire. They will wisely avail themselves of the assistance of the spade, and they may even find it desirable, either to carry with them, or to draw upon occasion from the Engineers' stores, as may be thought best, a supply of suitable mantlets for the protection of the gunners. These have been already much employed, and they will in time become indispensable for guns of position, and for all siege batteries, against an enemy possessing good sharp-shooters, and armed with improved rifles.

I need hardly observe that many of the remarks which I have made are only applicable to such circumstances, and that the employment of artillery against a foe not possessing these superior weapons will be less modified. A noble use of artillery has, for instance, been made by Lord Clyde, during the recent operations in India; and much loss to his infantry has been saved, both by this means and by a judicious application of the Enfield and Lancaster rifles.

As to the assertion that we shall not have rapid or decisive results by playing at "long bowls," I would remind you for a moment—my time will not permit me to do more—of the fact that we are not now beginning to play at long bowls; but that it is a game which has already been played with decisive results for a long time; and that the only difference is this, that, as our weapons improve, we must inevitably proceed to play at "longer bowls" than we did before. Inasmuch as houses, villages, en-

trenchments, and posts, may be more tenaciously defended, so we may expect a corresponding increase of close fighting, in any attacks made in future upon them; but, in the plain, the increased range and accuracy of artillery and musketry fire will produce greater effects, and therefore more decisive results, in a shorter time than before. Excepting in those parts of them where posts and buildings have been defended, great battles have already been principally decided, and will in future be decided to a still greater extent, first, by the amount of destruction caused by the respective fire of the opposing parties, and secondly by the *moral* effect of an advance. Jomini, whose experience was very great, first under Marshal Ney, and afterwards with the Russians, in the early part of the present century, says, "Scarcely anywhere, but in villages or in defiles, have I seen actual conflicts between columns of infantry, the heads of which struggled by the push of bayonets; never in the field of battle have I seen anything like this." David played at long bowls decisively enough against Goliath. Our archers of the 14th century played this game with extraordinary effect. The Battle of Homildon in 1402 against the Scots was won by the archers, while the men-at-arms looked on. At Leipsic, in 1813, there was a noble game at "long bowls." After the Allies had attempted unsuccessfully and with fearful loss, on the 18th of October, to produce decisive results by close attack, they collected 800 guns in a semicircle, and, playing for four hours upon the French, they inflicted losses upon them which compelled their subsequent retreat, and sealed Napoleon's fate. The French columns attempted again and again to move forward against this fearful storm, but they were swept away as often as they advanced; and their most determined efforts were unavailing. With all his disregard for human life, we cannot suppose that Napoleon, when his empire was tottering in the scale, would on this occasion have refrained from employing rifle skirmishers against the allied gunners, instead of sacrificing his devoted columns, if he had been possessed of modern means; or that he would have been prevented from doing so by any consideration of the misfortune that would attend an alteration in the existing relation between the three arms.

With regard to such relation, it is almost needless to observe, in the words of the homely proverb, that we must "cut our coat to suit our cloth." The relative capabilities of the three arms must always determine the relation that will subsist between them, and the only way in which we can alter that relation is by changing those relative capabilities.

Then, again, when it is asserted that the bold bowmen of Cressy and Agincourt would disdain to be associated with modern riflemen, let us remember that these bold bowmen were themselves guilty of shooting the poor Genoese archers at a time when the strings of their cross-bows had been relaxed by the rain, and when they were, therefore, unable to retaliate. If, in times to come, the spirits of the said bowmen should be disposed, as our author seems to anticipate, to reproach our future heroes for cowardly devices—"for displaying their skill," as he says, "in destroying their enemies" with "a minimum amount of danger to themselves,"—the riflemen will be able readily to reply, that the bold bowmen always did much the same, inasmuch as their shafts flew further, and with more effect, than the bolts of their opponents; and, in truth, it is just the principle

thus enunciated which is the foundation of good generalship, and the aim and object of all fortification.

It is highly gratifying to see that our gallant artillery are no more afraid of these deadly riflemen than they have been in past times of any other of their country's enemies; but we must not permit them to engage in so useless and unequal a contest as a duel of spherical or any other case against extended musketry skirmishers. It would be most unwise to do so when they are required for duties of much greater importance, in which we are quite unable to act without their assistance.

Neglecting many points of interest connected with future tactics, to which I had hoped, in preparing this lecture, to be able to refer, I must now pass rapidly on to the next portion of my subject—the influence of the spade upon field operations as they will now necessarily be conducted.

By the spade, as referred to in the title of my lecture, I do not intend to speak of a mere digging instrument; but I refer to it as emblematical of the means by which a soldier may be covered from his enemy, and may have the great advantage of dealing out his sixty rounds of ammunition, or as many as he can usefully employ, from a position of comparative safety. Just as the term crinoline has been accepted by the British public, as indicating the stick-out-a-tiveness of feminine costume, in spite of the probability of crinoline itself in most cases having nothing to do with it, so I would put forward the spade as a generic term for all those contrivances in which it may or may not take part, and which are included under the title of Field Fortification.

The soldiers of ancient, and the knights of mediæval times, protected themselves, as we all know, by means of armour, which they carried on their persons. This at last became so weighty as to leave its bearers, when once they fell, or were overthrown, a helpless, though somewhat difficult, prey to their unarmed foes. But it did not serve, with all its weight and strength, efficiently to protect them against improved weapons, and, as gunpowder came more and more into use, it was finally abandoned.

The shelter that ceased to be available against the weapons of former days, cannot *à fortiori* be usefully employed against those of the present day; and now that armour is more than ever required,—now that it is even wanted to preserve a body of men from the fire of half-a-dozen hidden skirmishers half a mile distant from them, or from the accurate fire of much more distant artillery, it becomes still more difficult, in spite of our improvements in manufacture, to provide any portable means of protection that shall be available for our soldiers in the field. But, as with most other difficulties, so also with this one, there are ample means of meeting it, if we do but look it fairly in the face, and if we properly prepare before hand those requirements which are necessary to enable us to provide against it.

Although our soldiers cannot carry on their persons any armour that would be useful to them against rifle bullets, or, with their impedimenta, any that would avail against artillery shot and shell, yet they may find on every well-selected battle-field, and on almost every position that they can be called upon to occupy, a plentiful supply ready to their hand, if they be but taught to use it, and if they be so placed as to be enabled to take advantage of it. Hedges, walls, banks, woods, undulations of the surface

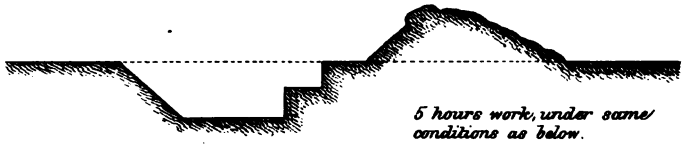
of the ground, may be partly made available, as they have been in former wars, in the state in which they are found; and may often with skill and labour be converted, in a comparatively short period, into works of an importance which in earlier times was better understood, which has of late been too little appreciated, but which, for the future, can hardly be over estimated.

This desirable object cannot, however, be obtained without previous preparation. In order to make the most of natural features, the highest skill must be at hand; in order to improve them during the short time that may intervene between the occupation of a position and the attack of an enemy, an abundant supply of labour must be forthcoming; and in order that that labour may be cheerfully given, and usefully bestowed, sufficient instruction and experience must have been afforded to the military workmen. Besides which, I may add here, that a reasonably liberal allowance of working pay sweetens the labour of the soldier, as well as the labour of any other class of his countrymen.

The detailed principles to be followed in strengthening a battle-field are evidently widely different from those under which works of a more permanent nature are constructed. The main principles, indeed, are the same, in the sense in which Napoleon and other great commanders have said, that "all war should be carried on in accordance with the rules of fortification." But there are clearly important minor distinctions to be kept in view, subject to the discretion of the general and the engineer, in the different cases that arise. In the first place, the more permanent the entrenchment or fortification is intended to be, the more must its facilities for offensive operations be made subservient to its defensive requirements; and, *vice versâ*, the more ephemeral the entrenchment, the more must the defensive works be laid out with a view to offensive movements, to be undertaken by the defenders at the proper moment. Secondly, in the preparation of a battle-field, or in the presence of an enemy, when there may be but little time allowed, before an attack is to be expected, the utmost use must be made of natural features, and the works must be so laid out, in a great measure, as to afford a maximum of advantage from a minimum of labour; while in works that can be more deliberately executed, and in which time is not so much an object, a greater amount of labour may be afforded, and ultimate efficiency be more perfectly attained. In the former of these two cases, more skill and readiness will be required on the part of those who design and superintend the execution of the works, than in the latter, in which more time can be afforded, both for reflection and for labour.

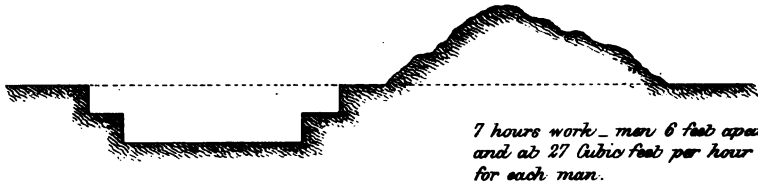
There is this material difference also (arising out of the former of the two considerations thus presented) between the two classes of works to which I have referred. Works of a more permanent character, defended by a smaller garrison, must be made more or less secure against assault, by means of a ditch placed in front of the parapet, and of palisading, abattis, chevaux-de-frize, or any obstructions that may be at hand; as well as by means of a flanking fire, obtained from suitable indentations in the parapets, upon an enemy attempting to pass such obstructions. But impediments of this nature, applied injudiciously to the more ephemeral entrenchments of a battle field, may be productive of much mischief.

Fig. 1.



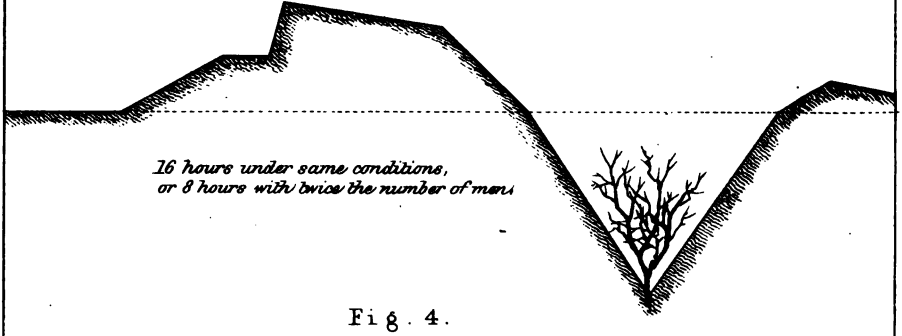
5 hours work, under same conditions as below.

Fig. 2.



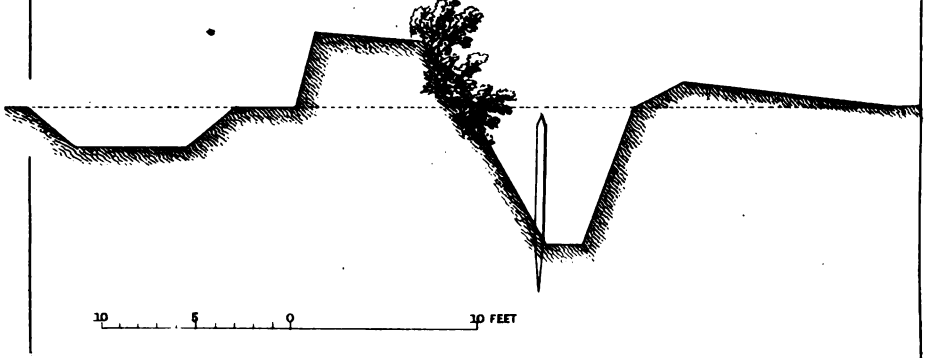
7 hours work – men 6 feet apart, and at 27 Cubic feet per hour for each man.

Fig. 3.



16 hours under same conditions, or 8 hours with twice the number of men.

Fig. 4.



J.R.Jobbins.

They may be so disposed as to offer an obstruction which is not required, or even shelter, to an attacking enemy, while at the same time they may prevent the troops in their rear from advancing in turn to the attack, or may oblige them to march out through narrow openings, at a time when their assailants have been disordered by their advance, and can be advantageously assaulted.

Such works will, in general, be most useful when they offer no impediment to troops marching over them, when they are entirely open to assault, when they have no indentations in the parapet except such as are required from the nature of the ground, and when they are so disposed as to concentrate their fire upon the approaches in their front, which are available for the advance of the assailants, taking the latter both in front and in flank, when such can conveniently be done. The defenders will not then be hindered in any manœuvres that may be required of them; they will be enabled to utilise their own fire to the utmost, from a position of comparative security; and they will be prepared to step over their parapets, and advance to the charge, in a perfect order of formation, if such should be necessary, or when it might be desirable.

There must, of course, be certain points in almost every position which it is important to entrench more strongly, and to render secure against assault: such as advanced posts, before which it may be desirable to detain the assailants, under a heavy fire, perhaps, from other parts of the field; or posts on the flanks, which it may be necessary to prevent the enemy from getting possession of at all hazards; or decisive points, which may be strengthened without interfering with offensive movements, and the loss of which would endanger the security of the whole position.

The greater the importance of such points or posts, the more strongly, of course, they should be fortified, according to the time and means at the disposal of the engineer; but frequently, the advanced posts, in particular, being placed under an overwhelming fire from other parts of the position, may advantageously be left open to the rear. If closed all round, and made equally strong in one part as in another, or if made too strong in the rear, they may become, when once taken, as great an advantage to the enemy as they were before an obstruction to him; but, if left open towards, or commanded from, the rear, then an enemy may find it impossible to retain them, even after having sustained heavy losses in getting possession of them.

The profiles of battle-field entrenchments, to meet the requirements which I have above indicated, may be constructed as shown in the annexed diagram, figs. 1 and 2 being types of those to be most commonly employed, and figs. 3 and 4 of those in which increased security becomes necessary. They may, in most cases of soil and situation, be executed in a night, and they may often be completed in a few hours, if only there be workmen to construct them, and officers to lay them out, without hesitation or delay, and to superintend their completion.

It will be impossible to give, in the time that is here allowed, the details of such operations. They would be similar to the works already prescribed for siege trenches and field fortifications; and for these I would refer you more particularly to the publications of Captain Macaulay and Colonel Jebb, and to the excellent article by the latter on field fortification in the *Aide*

Mémoire of the Royal Engineers. I may state, however, generally, that about 1000 workmen would be required for every mile of the simpler forms of entrenchments, and that their period of labour would average, in ordinary soil, four or five hours; while a man per lineal yard, and a period of at least eight or ten hours, might be required for more defensible works. The workmen would, of course, be placed in closer proximity where the work was heavier, and further apart where it was less laborious, and such averages must, of course, be taken as subject to great variation. In some cases a hedge-row may be converted into an efficient earthen screen, passable by troops, in a couple of hours; in others, protection may be only inadequately obtained after the hard labour of two reliefs of workmen.

No rules can be laid down, except those contained in the principles above enunciated, for the disposition of such works in plan. That must depend entirely upon the nature of the ground to be defended, and the character and composition of the troops; but the amount of work will be materially increased or diminished according to the judgment with which the entrenchments are laid out on the ground. The selection of the proper portion of a slope, the adoption of a suitable line of hedge, may save the workmen hours of labour, at the same time that it increases the efficiency of the position, though the great point, and that to which all these considerations must be subordinate, is to develope fire upon an advancing enemy.

The temporary parapets or mounds to which I have referred, may the more properly be considered as the armour of the modern soldier, because they are solely intended to shelter him from the enemy's missiles, and have not the effect which fortifications, in the common acceptation of the term, are intended to possess. They are more particularly applicable to the *defensive-offensive*, or *Wellingtonian*, system of operations, as it is termed, to which our great successes have been mainly due, and for which British soldiers have been found, by much experience, to be best adapted; and it is to this system, of which offensive action, assumed at the right moment, is the soul, that my remarks have hitherto been mainly directed. In employing it, the British commanders trusted principally, in the wars at the commencement of the present century, to the cover of natural slopes, and the assistance of any obstacles that presented themselves in the positions they selected, as at Waterloo, for the protection of their men, who were otherwise exposed, for the most part, to the fire of the enemy; and they have only occasionally made use of entrenchments, as at Fuentes d'Onoro, in the manner indicated. They might have done so to a greater extent on many occasions with manifest advantage; and even at Waterloo much loss of life would have been saved, had more sappers, more tools, and an infantry better instructed in, and prepared for, field engineering, been at the disposal of our great commander, during the hours that intervened between the time when the position of Mont St. Jean was first occupied and Napoleon's attack.

It is impossible to read without a feeling of indignation that, though they had plenty of time on the morning of the battle, the little party of heroes at La Haye Sainte were unable to make the most of their position, because their best workmen had been sent to the post of Hougoumont, and

because *the* mule which carried their tools had been lost, so that not even a hatchet was forthcoming in the hour of need.

At Fuentes d'Onoro, as has been recorded by Sir William Reid, entrenchments were thrown up by the Allies on the night of the 5th of May, 1811, after the severe battle of the preceding day; and the support thus afforded to the exposed part of the allied position saved Wellington from further molestation. Massena, who commanded the French, after lingering about the spot for some days, left Almeida to its fate, stating, by way of excuse, that the enemy "had drawn to their assistance all the resources of fortification against an attack by main force."

The Russians have, perhaps, been more remarkable than any other nation for the useful application of temporary entrenchments. The redoubts employed by Peter the Great at the battle of Pultowa, in 1709, enabled him to destroy the prestige which nine years of victory had given to the Swedes, and, thoroughly defeating Charles XII., to prevent him from advancing, as he intended, upon Moscow. A century later, the redans on the left, and the redoubt towards the centre, of the Russian position at Borodino, afforded Kutusoff the means of standing firmly, with an army partly composed of irregular troops and militia, for a whole day, against the veteran army of Napoleon; as well as of inflicting on that army a total loss of killed and wounded greater than he himself received. Within the last few years, also, we have had another remarkable instance of the perseverance of the Russians in, and their adaptation for, this mode of fighting, in the prolonged resistance which they offered to the allied forces of France, England, Turkey, and Sardinia, before Sebastopol.

More permanent works or positions, such as were prepared or occupied, in the defence of Provence by Marshal Berwick, towards the beginning of the eighteenth century; in the defence of Ardennes by General Dumourier, at the head of the Republican army, towards the close of that century; or in the Duke of Wellington's defence of Lisbon, by means of Sir Richard Fletcher's celebrated "Lines" in 1810, hardly come within the scope of our present subject. The position of Bautzen, again, formed during the previous three months, in which, although it was partly turned, the Russians and Prussians withstood for a time, and caused great loss to, an army composed of nearly double their numbers under Napoleon, in 1813, is an instance of more elaborate works, only applicable to special cases; as is also the position of Dresden, carefully prepared, and too long maintained, by Napoleon himself in the same year. The entrenched position at Buntzelwitz, formed during four days (or ten, according to other accounts) by the Prussian engineers, under Frederick the Great, in August, 1761, has been given as one of the most happy instances on record of a combination of art and *coup-d'œil*, and an adaptation of trace and detail to the force and constitution of the army for which it was formed. If prepared for some time before they are required, with the knowledge of the enemy, such works may often be avoided or turned, and thus rendered useless; and, though of great importance under certain circumstances, they can never be capable, like the impromptu entrenchments that have become necessary for the protection of future armies, of universal application.

The latter are analogous, however, to the works carried on by the

assailants during the siege of a fortified place. Here, as well as in minor operations of attack, and even in the field, there are frequent cases in which it is highly important to maintain a post which has been gained, or a position which has been conquered, as a starting-point for ulterior operations. Under these circumstances, entrenchments become most valuable accessories when they can be thrown up on the spur of the moment, either for independent action or for increasing the means of resistance afforded by obstacles already on the spot. It is sometimes of great consequence, also, to be able to reverse, in the shortest possible time, the defences of an enemy's works, captured in the course of an attack, which must be rendered secure before a position can be safely occupied, or before subsequent defeat can be guarded against.

In illustration of the value of experienced or instructed soldiers, under skilful officers, in former wars, I may quote the following instance of what occurred near Bayonne in 1813. I give it in the words of the late lamented Sir William Reid, of the Royal Engineers, from whose valuable paper on "Intrenchments as supports in Battle," (published in the second volume of the old series of the Royal Engineer Professional Papers,) I have derived a part of what I have endeavoured to convey to you on this subject.

Sir William Reid says, "It deserves here to be recorded, that the outposts of the 52nd Regiment had been so well fortified by the late Captain George Barlow, of that regiment, that the pickets had no occasion to retire until they had fired their sixty rounds of ammunition. This officer had taught himself how to strengthen posts by barricades and other temporary expedients; and he deserved the support he always received from the Engineers, who supplied him with what he required from their small dépôt"—may we have no more *small* dépôts!—"of entrenching tools. The pickets being thus enabled to hold their ground, without risk, for a considerable time, the troops for the defence of the main central position had full time to assemble (for it was in December, and they were scattered in houses), and to deploy in the position, the greater part somewhat retired behind the slope of the ground. There was nothing in the defences which impeded the usual formation, and everything was prepared to maintain this ground offensively."

The experiences of former warfare are exceedingly valuable as guides and beacons; but they only feebly indicate the requirements which will evidently be demanded in future combats. Infantry and artillery fire have now acquired a fearful increase of power, and it seems probable, that entrenchments, instead of being useful auxiliaries, to be employed occasionally, will eventually become a main feature, even of operations conducted in the open field. When an enemy is near at hand, all the exposed outposts of an army will require to be protected; and masses of infantry and cavalry must, as well as artillery, be placed under artificial shelter, whenever their position will allow the enemy's skirmishers to approach in sight, within half a mile of them, or the enemy's artillery within two or three times that distance. Every post must be entrenched which it is of importance to defend; and no time must be lost in entrenching a position taken from an enemy which it is intended to maintain.

The Roman legionaries were employed to fortify their camps with a

rampart some 12 feet high and 12 feet or more wide, armed with strong palisades, and with a ditch of corresponding dimensions in its front; and it is estimated by Gibbon that a Roman camp for 20,000 men would be about 700 yards square, and would therefore contain 2,800 running yards of rampart. Works of similar magnitude will be required for the protection of future armies: although modern skill will be better able to dispose its parapets, and will not in most cases demand, for temporary purposes, so much earthwork per running yard, yet still greater extension in length may often be necessary, and all the available labour of an army will not be too much for the performance of such works as it will be desirable to execute in the time that can be allowed for them.

Here, then, we have an evident want. It is clear that the lives of our soldiers, and the efficiency of our armies, will much depend, in future, upon the means that they may possess of entrenching themselves. The principles upon which they must do it are tolerably well known. They were stated by that master in tactics, Frederick the Great; and they have been more or less enunciated by our greatest engineers, our gallant Chairman, the late Sir John Jones, and Sir William Reid, among the number. The details for carrying out those principles, as applicable to analogous operations, have been practically worked out and published by Sir Charles Pasley and Colonel Jebb, and the writings of the former have served as a guide for, so-called, more warlike nations, as well as for our own service. But sufficient means of instruction has not yet been afforded to the officers who may command our future armies, or to the men who will compose them, either fully to appreciate the importance of these things, or to prepare for the new requirements that are dawning upon us.

I say sufficient means of instruction to our officers and men has not been afforded, because I know well that nothing more is required. There is no deficiency of zeal in the mass of our army, any more than amongst Englishmen of any other class. No pains will be wanting on their part, to perfect themselves in that which they see to be necessary to their efficiency, when proper opportunities are placed within their reach.

If we were *now* called upon to take the field, our army would not be composed of officers and men so skilled and practised in such operations as to be enabled to derive the greatest advantage from them; but there can be no good reason why this should be so. There is nothing abstruse in the science of field engineering; no difficulty in teaching it or learning it. It has been proved by the Engineer rifle practice, that the man who is taught to dig does not shoot worse than the man who is more exclusively trained to the use of the rifle. An infantry officer who is also a field engineer, will post his men at least as judiciously, and will lead them quite as bravely, as any other, while commanding them with greater confidence in his own resources, and possessing more moral influence over them. The best infantry that a nation could now possess, would be one in which every man was not only an efficient rifleman, but also a well-trained sapper, and in which every officer was a field engineer; and there can be no doubt that an infantry of this description, supported by a proper proportion of the other branches, is the army that is now required "to go anywhere and do anything."

The number of our Sappers, too, is very small considering the amount

of work that will evidently be required of them, either in the field or in siege operations. Three thousand rank and file, besides five hundred in India, are the total number provided for the corps in the Army Estimates recently laid before Parliament; and, looking to the multifarious duties that are required of these men in all quarters of the world, it will be seen that only a portion of them is available for active operations at any one particular point. Now that science and "industry" are tending more and more to take the place of "vive force," it will no doubt be found necessary to augment that number very considerably, however much the soldiers of the line may improve in the practice of field engineering. Indeed the two must naturally advance together, because the more the infantry become useful in these respects, the more will they demand superintendence, assistance, and attendance, from the special corps; and the latter will be more than ever required to carry on with promptitude those works for which they are more particularly adapted; including the laying down of telegraphs, the construction of bridges, the art of photography; and extending from the survey of a country to the sketch of a camp, from the construction of a railway to the repair of a shovel, from the entrenchment of a position to the digging of a rifle-pit.

But, besides the question to which I have been referring, of providing earthen shelter for him, or rather teaching him to provide it for himself, there are other matters of equipment and preparation which must be carefully considered with reference to the altered position of our infantry soldier, if we wish to raise him to the highest degree of efficiency.

Napoleon has observed that two-thirds of the strength of an army depends upon moral influence; and all history has confirmed the assertion. Let us take the instance of Pultowa above referred to. Before that battle, 8,000 Swedes had, as Voltaire observes, destroyed ten times their number of Russians in an entrenched camp at Narva, and 18,000 of them would have attacked the whole force of Russia, and would have perished to a man rather than have surrendered. After that battle, their prestige gone, their king, whom they had hitherto regarded as invincible, wounded, and absent, they gave themselves up in masses to their pursuers.

Now, moral influence, as here employed, is nothing more than a conscious or assumed superiority on the one side, opposed to a conviction of inferiority on the other; and it is a quality which can and ought to be cultivated, by the improvement of the soldier's intellectual and physical condition. To the natural steadiness and determination of the British soldier, ought to be added that self-confidence which arises from experienced fertility of resource; and the feeling of superiority, in which the Anglo-Saxon is sufficiently inclined to indulge, ought to be strengthened and justified by improved general intelligence, as well as by increased proficiency in those offensive and defensive arts which are necessary to his profession.

One of Colonel Jacob's opponents, writing in the *United Service Journal* under the signature, before referred to, of "A Field Officer of Artillery," attempts to turn him into ridicule, for linking improved rifles and educated soldiers together, and for supposing that there is any necessary connection between the two; but it is now placed beyond a doubt, by the light of experience, that, up to a certain point, increased intelligence actually produces better shooting. Indeed, it has even been urged on the other hand, and with

better reason, that the want of sufficient intelligence in the soldier will be an impediment in the way of his making the best use of the most perfect weapons; and that therefore it is not desirable to furnish him with the best rifles that can be made. One reply may, however, be made to both of these statements. It is alike possible and desirable, by a judicious system of education, and particularly of professional education, to increase the intelligence of the soldier; his learning to shoot alone will increase his intelligence to some extent; the more his intelligence is increased in other ways, the better, up to a certain point, will his shooting become; and, in proportion as his intelligence and his good shooting progress together, in the same proportion will his value be augmented for the service of his country.

The time has gone by when it could be seriously discussed whether an indifferent class of men did not make the best soldiers, and whether the subordination of the soldier, so necessary to military discipline, would not be injured by increasing his intelligence, and his means of forming a judgment on the measures of his superiors. If that were true, the men of the Royal Engineers ought to be the most insubordinate, and the most difficult to command, in the service, instead of being, as they are, men who will turn their hand to anything that may be required of them, in peace or in war, under fire or under water, in strict obedience to the orders of their officers. Education is fortunately now on the increase in the army generally; and we shall not look in vain for a good result, when it shall have been fully brought to bear; but, in the meantime, the great want that appears to exist, is in this matter of field engineering. We have got instructors of musketry: would it not be desirable also to have instructors of field engineering, either combined with that office, or distinct from it, as may be thought best?

A great deal has been said from time to time about the dress of the British soldier; and this is a subject, no doubt, of increased importance in connection with the accuracy and range of infantry fire. In reference to it I should be glad to draw attention to the tables here shown,* which I have extracted from a valuable little work by Colonel Le Couteur, the Adjutant-General of the Royal Jersey Militia. Colonel Le Couteur deduced these tables from experiments made with pieces of cloth stretched upon a frame, which he observed at various distances, and in different states of the atmosphere. As far as his experiments go, the result appears to be, that we need have no apprehension as to any necessity for abandoning our national colour. It has the great advantages—now more than ever essential—of enabling British troops to recognize each other with readiness, of being imposing in appearance, of exhibiting a less ghastly appearance than most other colours on wounded men. It is the proud emblem of many a hard-fought field, and many a well-earned victory; and, whilst it is the most distinct colour, next to white, at short distances of 300 yards or so, in a clear, bright state of the atmosphere, it is, at the same time, not so well seen as white, blue, rifle-green, or stone-colour, under less favourable circumstances of light and distance. I may observe, however, that these results are materially affected by differences of position and background.

* *Vide* p. 192.

I should also be glad, before I conclude, to say a very few words on that portion of the much-vexed question of national defence which is immediately connected with our present subject.

Our position in this respect, in the middle of the nineteenth century, is in painful and discreditable contrast with that of our ancestors. Four or five hundred years since, it was the fashion for English kings and princes to lead small armies across the water, and to defeat, as at Cresy, Poictiers, and Agincourt, any number of foreign troops that could be brought against them. In the present day, we ourselves indulge in periodical panics, apprehensive lest our gallant allies should take it into their heads to cross the Channel, without giving us time to prepare a fitting reception for them; and what is the cause of the contrast thus presented?

The application of steam to vessels of war, while operating for the most part to our advantage, has partially bridged the Channel, and has rendered the passage of it more easy than it was before, in the event of our fleets being engaged in other duties than that of guarding our coasts. Our neighbours are now in possession of fleets and armies, too numerous to be intended solely for defensive purposes, and far too highly organized to justify any feeling of security on our parts, so long as we remain unarmed, or only partially prepared for resistance. But English soldiers have not become less valorous, nor have French ones surpassed them, individually, either in bravery or efficiency. The principal reasons for this contrast, as far as we ourselves are concerned, may be combined in a sentence, composed—first, of the words of the old writer, who said, "The might of the realm of England standyth upon archers;" and, secondly, of the opposite truth, in which it may now be justly alleged, that "the weakness of Great Britain lieth under a want of riflemen."

In former days, the practice of archery was enforced by law; at present, rifle practice is not encouraged. In those days every householder, who did not supply his children and his servants, between the ages of seven and seventeen years, with a bow and two arrows, was fined 6*s.* 8*d.* a month. The practice of archery was then universally enforced; restraints were laid upon other games that were likely to interfere with the use of the bow; and Englishmen of full growth and maturity, were prohibited from firing at a mark less distant than 120 yards. In these days, we are only beginning to avail ourselves of the advantages to be derived from a school of musketry, and proficiency in the ordinary weapon of the soldier is limited to a number insufficient for the defence of the country.

We have no desire to emulate the aggressive spirit of the times referred to, but we should at least secure our own shores, and our own hearths, from the possibility of insult. We can do so with little trouble, and at a cost from which we ought not for a moment to shrink. The rifle increases the power of the defensive element in field operations enormously; and trained riflemen, when placed behind entrenchments, are not inferior to regular troops. I do not advocate what is called putting the rifle into the hands of the people; but I assume that a hundred thousand volunteer riflemen might, without difficulty, be selected from a class of men who would be ever ready to protect us, alike from foreign invasion or from internal disturbance. A sufficient number of sappers to provide entrenchments, in suitable positions, for the action of such

volunteers, would now be of inestimable value for all other military operations. The volunteer sharpshooters would harass the flanks and rear of the invader, and would also be enabled to aid the regular troops and militia, in disputing the country, mile by mile, with any foreign army that could in the first instance be brought into it, in a manner that would render advance impossible.

If the Thames were protected, and the great arsenals and dockyards of the country secured from sudden attack, by fortifications adapted to the circumstances of modern weapons; and if, in addition to our smaller force of regular troops and militia, of artillery and infantry, volunteer riflemen and sappers were available for action in sufficient numbers on the shortest notice; we should then not only be enabled to feel a security which we do not now possess, but we should also assume an attitude of defence that would of itself go very far towards preventing any serious contemplation of hostile invasion. We should also be at liberty to employ considerable portions of our fleets upon such distant duties as might be urgently required of them, in maintaining our naval supremacy in every part of the globe, instead of being obliged to collect them in the greatest possible number, in feverish anxiety, for the vital object of defending our coasts.

Such is a brief sketch of the system of national defence which appears to be suited to the requirements of the present time. Railways and telegraphs, rifled muskets and rifled cannon, ready means of intrenchment and revised systems of fortification, well-trained officers and intelligent soldiers, are our modern means and appliances. With diligent preparation, and a right use of them, we may defy aggression, and, by God's blessing, we may confidently expect to carry high the banner of our country through any future contests in which we may be called upon to participate. Without such diligent preparation, and without present judicious expenditure, we must ever feel anxiety and uncertainty as to the issue of our first operations; however great the confidence with which we all look forward to ultimate success.

If we may judge by what is said and written, there would appear, however, to be much misapprehension in the public mind as to the fitness of this country for defence in its present state. The popular idea is, that the fences with which it abounds would be all in our favour, and that our skirmishers would have a simple duty to perform, in picking off their enemies from behind them. It is for the most part forgotten, that the invaders would find shelter as well as our own men; and that our hedgerows, by covering the advance of, and affording protection and support to, a hostile force, would, in their present condition, be quite as useful to our enemies as to ourselves.

The front of a position selected for defence, like the glacis of a fortress, should afford a minimum of shelter, in order that the fire of its defenders may tell to the utmost upon their assailants. In preparing a position for an engagement, therefore, in this country, more would have to be thrown down than built up; much judgment would have to be exercised, alike in the one case and in the other; and now that artillery and musketry fire are becoming more destructive, and shelter more important, officers and soldiers well trained as field engineers will be most urgently required.

It becomes desirable now to sum up, in conclusion, the changes that may be anticipated in future field operations, in consequence of improved shooting on the part of the soldier and the artillerist; the influence that such changes may be expected to produce upon the success of our arms; and the means by which they may be best turned to our advantage.

In the first place, we may take it for granted, and, whatever we may desire, we must accept it as a fact, that small-arms fire will eventually be enabled to produce destructive effects at ranges five or six times as great as those at which the musket of former times was properly used, when hostile forces, armed with the best weapons now supplied to the soldier, are in sight of each other; that artillery fire will be employed, when the ground will admit of it, at increased ranges; and, what is still more important, that it will be served with greatly increased precision. We may confidently expect, not only that the fire of skirmishers will be more effective, but also that it will, in consequence of its increased range, and its vast powers of destruction, when employed against troops in any sort of close order, supersede to a certain extent the present grape and case shot of field artillery, on the one hand; while, by its powers, when employed against uncovered guns, it will in some measure serve to prevent their action on the other. We can foresee that the field artillery service must therefore undergo a considerable change; and that it must now be more particularly perfected, by the aid of its newly acquired powers, with a view to its producing accurate effects, at longer ranges, with shot, shell, and case, against masses of troops, against an enemy's guns, or against parapets, buildings, works, and obstacles of whatever description, behind which an enemy may find shelter.

It is probable, that, though skirmishers will be employed to act against skirmishers, yet they will only be able to afford partial protection to the armies to which they may respectively belong. As it has been the general rule hitherto, in the service of field artillery, that it should be employed principally in firing at an enemy's masses rather than at his guns, so also skirmishers will be employed on both sides to the greatest advantage in future, when they conceal their own persons by natural or artificial means, and direct their rifles principally against the larger bodies of their enemies; and we may expect that they will to a great extent adopt this system of operation.

Concentrating in this manner a vast amount of accurate fire against an enemy's field artillery, to which, with its only partially divergent, and, under such circumstances, comparatively random, fire, it will be but ill able to reply, they will produce effects upon it which it will be unable, at ranges of 600 yards or so, to withstand, and which will compel it to act, when uncovered, from greater distances. Turning their weapons against an enemy's cavalry, they will without difficulty compel it, either to advance or to retire, if it have been injudiciously placed within their reach. The skirmishers on either side will, in fact, become so formidable, and will, seconded by the far-ranging power of more distant field-artillery, have the power of producing such deadly effects upon the masses of infantry, upon the cavalry, and upon the field-artillery of their opponents, that when hostile armies approach each other in future, they will be compelled, instead of sleeping within 1000 or 1500 yards of each other, as on the night which

preceded the Battle of Waterloo, to maintain a more respectful distance; and, at all events in the case of an invading army amongst a hostile population, to shelter themselves behind the best combination of natural and artificial cover that they can procure, as the only means of avoiding continual annoyance and gradual annihilation.

Such being the tendency of the newly-acquired means of offensive operation, it is evident that defensive measures, superior to any that have hitherto been employed, become, not only desirable, but absolutely necessary; and that that army which can cover itself most quickly, and most effectually, in taking up a new position in the face of an enemy, will possess an advantage second only to the employment of superior offensive weapons.

It will be conceded without hesitation, that the greater advantage to be derived from this increased power of the infantry soldier's fire will lie with those troops who are best adapted, by their natural capabilities, for acting in extended formations.

As an attack upon troops in position by troops in column will be more hazardous than it was before, and as any exposed deployment within 800 yards of such weapons will be attended with great loss, so those men who can stand longest, and with the greatest steadiness, against an advancing enemy, in that two-deep order which is best fitted for the developement of their fire, must have a greater superiority than ever over any opponents who do not possess a similar amount of natural "*impulsion.*" And, as the individual confidence of the Anglo-Saxon soldier is greater than that of the soldier of any other nation, so we have a fair right to conclude, that if he be provided with the best weapons, instructed in the best manner, and protected by earthen armour, when occasion requires, on the shortest notice, he will not only be willing, but will also be well able, to cope with superior numbers of any other troops with which he may be brought in contact.

Superiority in rifle fire, from large and small guns, is now, as archery was in former days, the first desideratum for affording our soldiers the advantage in the day of battle; and superiority in field engineering, on the part of our commanders, subordinate officers, and soldiers, becomes for the future only second to it in importance. In the former we may fairly hope to rival any other troops that we can have to encounter, from whatever part of the globe, if we only cast off all prejudice, and if, making proper use of the national wealth, the mechanical skill, and the means of manufacture which we possess, we adopt those rifled weapons, whether Lancaster, Enfield, Armstrong, or Whitworth, or any other, which, upon fair trial, are proved to be best suited to the various requirements of the soldier and the artillerist. In the latter we are miserably deficient. Our sappers are comparatively few in number; our infantry are in a great measure uninstructed in that which is so necessary to their future safety. Article 56 of the Queen's Regulations clearly recognises the want in terminating with these words: "the use of the spade, pickaxe, and barrow, is as essential for the defensive, as that of the musket and bayonet is for the offensive, operations of the army." But no adequate steps are being taken to further or facilitate the carrying out in practice of the wise maxim here so well enunciated. We have not yet, unfortunately, had the wisdom to discern, or at all events fully to appreciate,

through the haze under which improvement marches rapidly onward, and in which future requirements are shrouded, that the only antidote to, and the necessary attendant on, the growing perfection of rifled arms, is that one of the arts of the sapper which may easily be taught, in which a large proportion of our troops ought to be thoroughly instructed, and which is not I think inappropriately represented under the emblem of the *Spade*.

COLONEL LE COUTEUR'S EXPERIMENTS for testing the RELATIVE DISTINCTNESS of COLOURED CLOTHS at DIFFERENT DISTANCES.

	From 300 yards.		From Half-a-Mile on a clear day.	From One Mile on a clear day.	From Half-a-Mile and One Mile on a dull cloudy day.
	At day-break of a clear day.	At 10 A.M. of a clear day.			
White . . .	1	1	1	1	1
Blue . . .	2	3	2	2	2
Rifle Green . .	3	5	3	3	3
Stone Colour . .	4	3	5	4	4
Red . . .	5	2	4	5	5
Austrian Blue . .	3	4	7	6	7
Grey . . .	7	7	6	7	6
Brown (fern) . .	6	6	8	8	8

N.B. These results depend much upon the positions of the objects observed, and upon the background against which they are seen; and the brightness or dulness of the red employed, will have much to do with the distinctness of the colour.

1st class	650	6	3	4	5	13	15	2·25	2·25	58·33	58·33	6·30	8·50	1·05	
	700			4	6			1·57	1·75	37·50	47·61			1·00	
	750			4	5			1·50	1·50	41·66	41·66			0·74	
	800	7		3	5			1·50	1·50	48·66	48·66			0·76	
	850			4	5			1·20	1·20	36·66	36·66			0·67	
	900	8		3	6			1·42	1·42	20·00	20·00			0·64	

TABLE No. 2.

ROYAL ENGINEERS.—PRACTICE of DUTY MEN at HEAD QUARTERS, CHATHAM, for the year 1858-9, with the LANCASTER RIFLE.

Distance.	Percentage of Hits.	Distance.	Percentage of Hits.	Distance.	Percentage of Hits.
100 yards . . .	78·78	400 yards . .	47·34	700 yards . .	36·27
150 „ . . .	60·91	450 „ . . .	36·37	750 „ . . .	24·14
200 „ . . .	42·68	500 „ . . .	49·29	800 „ . . .	29·65
250 „ . . .	60·62	550 „ . . .	38·92	850 „ . . .	21·25
300 „ . . .	49·74	600 „ . . .	34·82	900 „ . . .	25·47
350 „ . . .	51·58	650 „ . . .	39·03		

SIR JOHN BURGOYNE.—Captain Tyler has given us a very interesting lecture upon a very interesting subject.

It is evident that the general introduction of the rifle into the service, and the greatly increased power that is rapidly being developed by means of rifled cannon, will require much alteration in the system of warfare, which will not be fully understood until after much studied consideration given to the subject, and much practice, and even experience in actual war.

Captain Tyler is early in the field of research, and has submitted many valuable observations as a commencement.

I will on this occasion only allude to one, which is the great necessity that will arise for troops to procure cover from the deadly aim of these perfect weapons, even at great distances; natural cover will be sought for with more eagerness and judgment, and greater efforts will be made to obtain artificial cover by spade and pickaxe: there is one great difficulty, however, with regard to the latter that will be much felt in the field, in the scarcity of the necessary tools and implements: Captain Tyler expresses a hope that hereafter this scarcity may cease; and I join him most cordially in that hope, but I fear we can hardly expect it in any very essential degree. The soldier clearly cannot carry them himself, and army transport is usually under the greatest pressure for provisions, forage, ammunition, and other objects of still greater need than tools; the only remedy will be increased instruction to the soldier to enable him to turn his scanty means to the best account; and every encouragement to be given to him to use more exertions in the labour of field work than has hitherto been habitual to him.

The whole resolves itself into what is becoming more and more apparent, that the soldier's is becoming every day more a skilled profession, and the well-practised soldier of increasing value over the raw recruit.

With regard to the effect of the introduction of these great improvements in warlike implements, *we* have no reason to fear the consequences.

The British soldier was pre-eminent in old times in the use of the bow. He has since then been as superior with the bayonet, and we have no reason to fear but that he will shine equally with the rifle!

I will conclude with proposing the cordial thanks of the meeting to Captain Tyler for his able and interesting Lecture.

Thursday, May 12th, 1859.

Lieut.-General the Hon. Sir EDWARD CUST, K.C.B., in the Chair.

ON NAPOLEON'S CAMPAIGN IN ITALY IN 1796.

By Colonel MACDOUGAL,
Commandant, Royal Staff College, Sandhurst.

I HAVE selected, as the subject of this Lecture, Napoleon's campaign in Italy in 1796, as being of peculiar interest at the present moment, on account of the resemblance which exists between some of its earlier scenes and those now being enacted on the same theatre. It is very remarkable to observe how, after a lapse of many years, the same military events reproduce themselves, so that hostile armies are found to occupy the same, or very nearly the same, positions as those which were chosen by the armies of former generations; and how it even happens that the contending parties fight on the very same battle-fields as have been moistened by the blood of their forefathers. A very short consideration however may convince us that this resemblance is a matter of necessity, since it arises from the natural physical features of the country, which do not change, such as the direction of the great rivers and mountain ranges, and the fertility or the barrenness of the different districts. These are the conditions which determine the choice and direction of military lines of operation, and even in many cases point out the exact spots where decisive engagements will be fought. Hence it arises, at this moment, that the eyes of Europe have been fixed with interest and expectation on the battle-field of Marengo, where the first Napoleon won his brilliant victory over the Austrian General Beaulieu, as being the probable scene of another great battle; and hence it arises, also, that the positions which are occupied now by the Austrians on the north bank of the Po are very nearly the same as those which Beaulieu occupied during the second part of the campaign of 1796.

In 1792 the war of the first coalition against France commenced, and I must refer you to general history for the military events of that year, and of the succeeding years, previous to 1796; indeed, the campaign of 1796 itself was of such extent and duration that it would be impossible, within moderate limits, to give any detail of all the operations. I must limit myself to treating them very much in a general way, selecting, however, two of the principal operations for relation in detail. I allude to the movements which preceded the battle of Montenotte and to those in the second part of the campaign which preceded the passage of the Po by Napoleon at Piacenza.

In the year 1796 the King of Sardinia was allied with Austria and England against France. The line of demarcation which separated the Austrians and Sardinians on the one hand and the French forces on the other was divided into two distinct parts; one, formed by the western

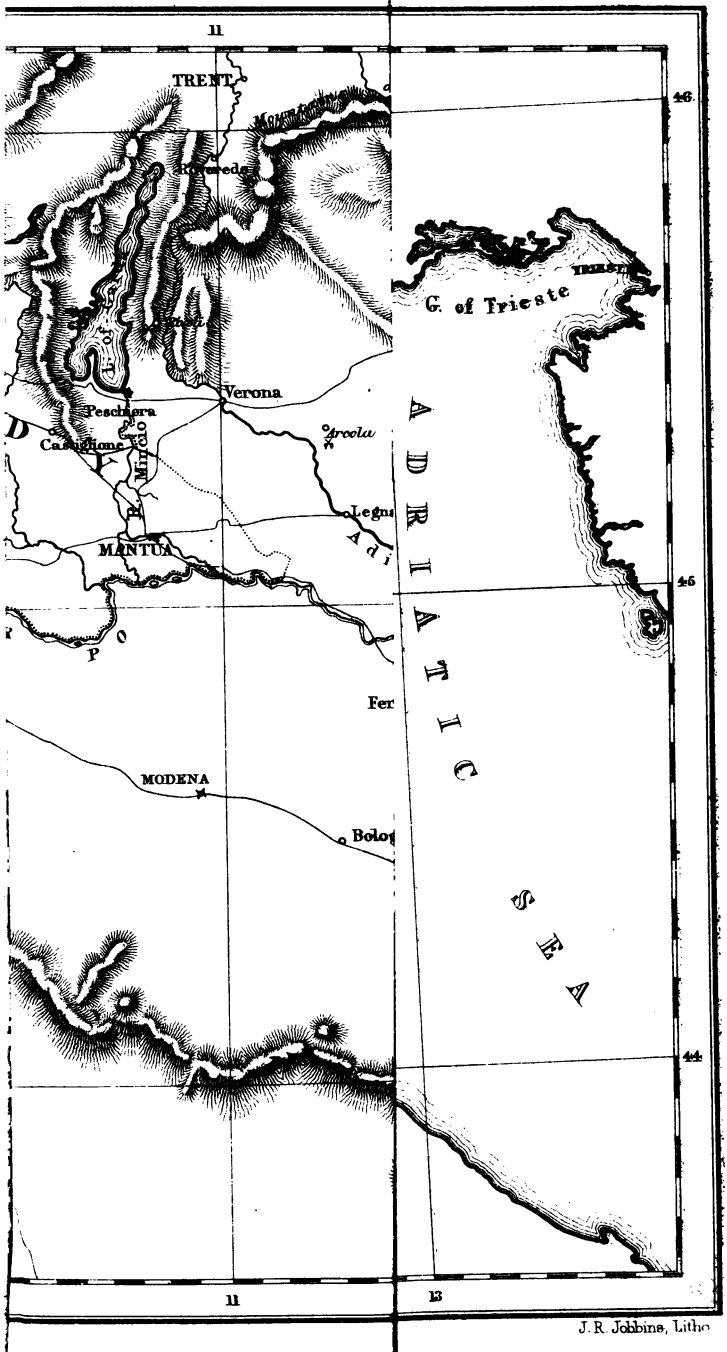
chain of the Alps from the Little St. Bernard on the north to the Col di Argentiera on the south, was guarded by a French force of 20,000 men, called the Army of the Alps, under General Kellerman; the other portion, extending from the Col di Argentiera on the left, and along the crest of the mountains to Montenotte on the right, was guarded by the Army of Italy, commanded by Napoleon himself. But it is easy to perceive the disadvantage which resulted to the French from occupying so extended a line. The different French corps, placed on the summits of the mountains, could only communicate with each other by a long march, which would occupy twenty days; while their enemies, situated within the concavity of that vast circumference, and able to march between any two points by the shortest possible line, *i.e.*, on the chord of the arc, could throw themselves in force upon any point which they might desire either to attack or to defend, in a far shorter time than the French would require to concentrate their forces at the same point. The French also suffered great hardships in obtaining supplies, arising from the badness of the mountain-roads, while their enemies in Piedmont were easily supplied with food and other requisites; and to these disadvantages must be added those of climate, for the French, posted on the mountains, lost as many men in the course of three months by sickness as would have been lost in a general action.

Now, to penetrate into Piedmont, over the western barrier, the French army must march by one of the five passes, the names of which are Argentiera, La Croix, Mont Genevre, Mont Cenis, or the Little St. Bernard. An army passing over the Col di Argentiera would descend upon Turin by one of the three valleys, viz., the Stura, the Maira, and the Vraita, guarded respectively by the forts of Demonte, Genola, and Castel Delfin. An army passing over the Col de la Croix would penetrate into Piedmont, and descend upon Turin by one of the two valleys of St. Martin or Pragelato, guarded respectively by the forts of Pignerolo and Fenestrelles. An army operating from Briançon would pass over Mont Genevre, and descend upon Turin by the valley of Pragelato, or by the valley of the Doria Riparia, guarded by Exilles and Susa. An army coming from St. Jean de Maurienne would march over Mont Cenis, and descend into Piedmont by the valley of Susa. This is the route which the French troops have now taken; they have crossed Mont Cenis, descending upon Turin by detachments. An army operating from Moutiers would cross the Little St. Bernard mountain, and descend into Italy by the Doria Baltea valley, guarded by the little fort of Bard, which so nearly rendered abortive Napoleon's famous campaign of Marengo.

To enter Piedmont, over the southern barrier, from Nice, four passes were at that time practicable for an invading army—First. The Col di Tenda, guarded immediately by the fortress of Coni, leading by Fossano and Cherasco, on to Turin. Secondly. By the Ponte di Nava, leading by Ormea, Ceva, Cherasco, also on Turin. This entry is defended by the fort of Ormea and the citadel of Ceva, but Ormea was in possession of the French. Thirdly. By the Col di Cadibona, leading by Cairo, and Acqui, on Alessandria. Acqui was a fortified town, and Alessandria was a first-class fortress. Fourthly. By the Bocchetta pass, leading by the fortified town of Gavi to Tortona.

At the commencement of the campaign, Napoleon's only line of com-

GN IN ITALY IN 179



munication with France lay through Nice. Nice is upon the coast line, and Napoleon's immediate base of operations may be considered to have been the strip of country, inclosed by the mountains on the one hand and the sea on the other, between Nice and Savona.

The English had the command of the sea, and the French, therefore, could not make use of it as a means of transport. The troops which Napoleon found at his disposition amounted to about 40,000 men, consisting of four divisions of infantry and two divisions of cavalry. Besides these, two brigades guarded the passes of Tenda on the left leading to Turin, and two divisions guarded the coast road from Nice to Turin.

Napoleon, on his arrival at the seat of war, found the army in a complete state of destitution with regard to food, clothing, transport, and supplies of every description. His troops were very much in arrears of pay, and he had no money wherewith to pay them; and there was great disorganisation and relaxation of discipline, as is always the case under similar circumstances. The first care of Napoleon was to provide for the immediate wants of his army, and to restore order amongst them; next to inspire his troops with an ardent desire to engage the enemy, by appealing to their national love of glory, and by convincing them that the only hope of any improvement in their condition lay in a victorious advance against the enemy. It was, indeed, impossible to remain stationary. Napoleon's resolution was taken to advance, to surprise the enemy by the rapidity of his movements, and to put in practice his favourite maxim, "que la guerre nourrit la guerre,"—meaning that war should be self-supporting. On the very day of his arriving at head-quarters, which was on the 27th of March, he issued the following order to his troops: "Soldiers, you are naked and starving; the government is much in your debt, but has nothing to give you. The patience and courage which you have displayed on these desert rocks are admirable. But these qualities are unable to procure you any glory so long as you remain here. I am about to lead you into the most fertile plains in the world. Rich provinces and great cities will be your prize. You will find in that rich country glory, honour, and wealth. Soldiers of Italy, you will not be wanting in either courage or constancy."

But it was easier to talk of leading his army to the conquest of Italy than to place it in a condition which could alone render that conquest possible.

Having succeeded in persuading a rich contractor to advance a large sum of money, the interval between the 25th of March, when he arrived, and the 9th of April, was incessantly occupied by him in re-organising his army, and bringing them out of the state of chaos into which they had fallen. His labours will be found detailed in the first volume of his Correspondence, which has been published lately by order of the present Emperor of the French. This correspondence is extremely interesting, and furnishes a proof, as indeed do the general orders of the Duke of Wellington and of all great commanders, how small is the proportion of the time and attention of a general which is occupied with the mere arrangements for fighting alone. Napoleon had to busy himself with the actual purchase of supplies of food, forage, and clothing, and particularly shoes; to procure military supplies of every description, and to store them in the different towns along the coast for the immediate consumption of his

army. He had to purchase horses and mules, and to create a transport train for the purpose of conveying supplies to his troops; and in this he was so successful that before the 5th of April his army was in a completely efficient condition, and he had inspired his troops with that enthusiasm and confidence in their commander which are such powerful contributors towards victory.

I will now turn to the positions which were occupied by the Sardinians and Austrians in Piedmont. On the extreme right a Sardinian force of 20,000 men, under the Prince of Carignano, guarded the passages into Piedmont from the western range of mountains, and was therefore immediately opposite to, and in observation of, the French army under Kellerman. The principal army of the coalition, consisting of a combined force of Austrians and Sardinians under the chief command of the Austrian general Beaulieu, was posted immediately opposite to the army of Italy, and was thus distributed:—The Sardinian portion of that army consisted of 20,000 men and 60 guns, commanded by General Colli. It had its head quarters at Ceva, but it was too much disseminated, since its general line extended from the valley of the Stura on the right to Millesimo on the left. It therefore had not that power of rapid concentration on any one point that it ought to have had. The Austrian portion of this army consisted of 40,000 men and 140 guns. Its right wing was at Sassello, under General Argenteau; and its left wing, divided between Voltaggio and Ovada, was commanded by Beaulieu in person. Thus we may consider that General Colli commanded the right, Argenteau the centre, and General Beaulieu the left of the combined force. Now this extended position occupied by his enemies suggested to Napoleon the following plan of operations: viz. to mass the greater part of his army on its extreme right, to pass the mountains by the Cadibona pass, and to overwhelm the Austrian centre before it could be joined either from the right or the left, then, turning suddenly upon the Sardinians, to compel them to conclude with him a separate peace in order to preserve their capital. Savona, a fortified sea-port, was a convenient place to serve as a depôt. From Savona to Madona the distance was four miles, over a carriage-road; from Madona over the mountains to Carcaria was seven miles, by a road which might be made, without much labour, practicable for artillery; and from Carcaria there were carriage-roads leading to the interior of Piedmont. The point at which the Alps and the Apennines join is the only one at which one can descend into the plains of Italy without finding intercepting mountains. So slight are the elevations that Napoleon projected a canal for the purpose of joining the Adriatic with the Mediterranean, by way of the Tanaro and Bormida rivers, it being designed to carry the canal over the mountains by means of a system of locks. On the 5th of April, having issued one of those electrifying addresses to his army which he knew how to employ to such good purpose, Napoleon moved his head-quarters from Nice to Albenga, and on the 9th to Savona, marching with his long train of artillery and engineer equipage by the then horrible Corniche road, in some cases almost within range of the guns of the English cruisers.

On the 9th of April, in preparation for his intended attack on the enemy's centre, the disposition of the French troops was as follows: two brigades guarded the pass of Tenda, and prevented the enemy from operating by

that pass to cut off the French communication with Nice. The division of General Serrurier was in the valley of the Tanaro, covering by his position the pass of Ponte di Nava, which also led upon Nice; and further it had this effect, that it occupied the attention of General Colli, and prevented him from detaching any large number of men to support the Austrian centre. Passing on to the French right, the division of General Augereau was at San Giacomo, and that of Masenna at Cadibona. From these places paths led over the mountains into the same valley as that in which Carcaria was situated. The division of General La Harpe was between Savona and Genoa. In order to render the attack on the enemy's centre more certain of success, it was necessary to divert the attention of the Austrian General Beaulieu from that point to some other. The centre was the point which Napoleon intended to attack, and he employed artifice to make Beaulieu believe that it was the Austrian left which he intended to attack, by forcing a passage through Genoa and marching by the Bocchetta pass and Gavi. Genoa, an independent republic, was in that dangerous and humiliating position in which weak and neutral states between two powerful belligerents must always find themselves placed. The neutrality of its port had been already violated by the English cruisers, and she was unable to protect herself from a similar insult on the land side. The artifice resorted to by Napoleon was this: he instructed the French envoy at Genoa to demand from the senate a contribution of 20,000,000 francs, and at the same time that the Genoese fortress of Gavi should be delivered up to the French; and, in order to enforce compliance with these demands, and to confirm the Austrian general in his belief that it was the Austrian left which was threatened by the French, one brigade of General La Harpe's division, under General Cervoni, was advanced to Voltri—Napoleon foreseeing the possibility that the Austrians from Sassello might make an attempt to march by Montenotte on Savona, and so cut off the French line of communication with Nice as soon as they believed him to be committed in a general advance upon Genoa, secured that passage by the construction of three redoubts on Monte Legino, a buttress shooting out from the main ridge and sloping gradually down towards Savona. The defence of these redoubts was entrusted to a detachment of La Harpe's division, commanded by Colonel Rampon; and on the gallant defence made by that detachment in those redoubts the whole of the subsequent operations hinged. In technical language, therefore, that point would be termed the decisive strategical point of the operations.

The Austrian General Beaulieu no sooner learned that the French had demanded the surrender of Gavi, and that the brigade of Cervoni had advanced to Voltri, than he formed his counterplan, in the execution of which his left was ordered to advance on Voltri; the centre under Argenteau was at the same time ordered to advance from Sassello, by Montenotte on Savona, and so cut off the French line of communication with Nice, hoping thus to inclose the French army between the Austrian centre and the left. In the execution of this plan, on the morning of the 10th of April, the Austrian left marched towards Voltri. The centre, under Argenteau, marched from Sassello and encamped that night at Montenotte. The leading columns of Beaulieu in the afternoon attacked Cervoni's

brigade behind Voltri; but the French held their ground, and retired after dusk to a stronger position in the rear. The position then of the Austrians on the night of the 10th of April was this: The centre had advanced from Sassello and bivouacked at Montenotte. The left had advanced upon Voltri; part of it was at Voltri, and the other part was marching towards that place. On the morning of the 11th, Argenteau, advancing from Montenotte on Savona, found his progress barred by the redoubts on Monte Legino; the Austrians attacked the redoubts at noon, and the contest was continued from noon until dusk, unsuccessfully on the part of the Austrians. General Argenteau drew off his men and bivouacked in front of the redoubts, with the design of renewing the contest on the following morning, taking the precaution, however, to detach one battalion to Ferrania in the valley behind to secure his right flank and rear. During the same day, Beaulieu attacked Cervoni at Voltri a second time, but the French held their ground.

Napoleon, now learning by the reports which he received from Colonel Rampon in one direction, and from Cervoni in the other, that the Austrian centre and left were attacking the French from two different directions, and that they could not communicate with each other, without marching over the bodies of the French troops interposed between them, prepared to strike his blows with that force and rapidity which so eminently characterised him. But Rampon had been hard pressed during the day, and all depended upon his holding his ground. The dispositions of Napoleon, and the movements which, in obedience to them, took place during the night of the 11th, were these: La Harpe was withdrawn from his position between Savona and Voltri, and sent to reinforce Rampon at Monte Legino. The brigade of Cervoni was ordered to fall back secretly during the night from before Beaulieu, and to join La Harpe's division, to which it belonged. This was effected, and before daybreak the whole of La Harpe's division was drawn up behind the contested redoubts. In another direction, during the night, Massena marched from Cadibona, and Augereau from San Giacomo, and uniting near Ferrania, overwhelmed the Austrian battalion, which had arrived there only a few hours before, and continuing their march by Lower Montenotte, ascended the heights behind the Austrian General Argenteau. Napoleon personally directed this movement. Thus, before daybreak on the 12th of April, Napoleon had succeeded in concentrating three of his divisions against the Austrian centre, and in cutting off that centre from all possibility of communicating with its right or left. The Sardinian army, forming the right, was held in check by a far inferior French force under Serrurier in the valley of the Tanaro, while Beaulieu at Voltri was held in check by the phantom of Cervoni, whom he believed to be still in his front, as well as by his general ignorance of the movements of the enemy. On the morning of the 12th, when day broke, the Austrian General Argenteau was astonished to find La Harpe's division drawn up behind the redoubts. La Harpe lost no time in attacking; and while the Austrians were hotly engaged with him in their front, Napoleon led up the divisions of Massena and Augereau, which he hurled against their rear. The corps of Argenteau was completely broken up. It suffered a most severe loss; and, the only road by which it could retreat being in the hands of the French, it was compelled to disperse over the

mountains, and finally the broken remnants of Argenteau's corps rallied at Dego. While this combat was going forward, Beaulieu, still at Voltri, advanced to attack Cervoni, who had retreated for the third time; but, finding no enemy in his front, and uncertain what to do, he remained stationary.

After the battle of Montenotte the positions which the different French divisions occupied on the night of the 12th were as follow:—The division of La Harpe was between Cairo and Dego; the division of Massena was advanced to Cairo; the division of Augereau was at Millesimo, where a detachment of Sardinians held the heights. Thus the mass of the French army was interposed between the Sardinians and their Austrian allies.

Early on the morning of the 13th Augereau, having bivouacked in front of the Sardinians, attacked them at Millesimo, defeated them, and compelled them to retire towards Ceva. It was only in the afternoon of the 13th that Beaulieu, still at Voltri, learned that his centre had been almost destroyed at Montenotte on the preceding day, and that there were hardly any Austrian troops to oppose the advance of the French troops upon Milan. It was necessary, therefore, at once to withdraw his left from its false position at Voltri, and he immediately ordered a concentration of his forces at Dego, hoping still to be in time to forestall the French at that place, but he was too late. At Dego the broken remnants of Argenteau's corps, which had been defeated at Montenotte, were joined by a part only of Beaulieu's left. During the night, or early on the morning of the 14th, the divisions of La Harpe and Massena attacked the Austrians at Dego, defeated them, and drove them back to Acqui, on the road to Milan. Beaulieu, on hearing of this fresh disaster, gave orders for the concentration of his army at Acqui. The Sardinians drew together at Ceva; thus the separation of the Austrians and the Sardinians became irremediable.

While Beaulieu, at Acqui, was occupied in reorganising the remnant of his force, Napoleon turned his whole attention against the Sardinians at Ceva, and leaving one brigade under Victor at Cairo to guard the communication with Savona from the attacks of the Austrians, he concentrated the rest of his troops round Ceva. It is unnecessary to enter into the details; it will be sufficient to say that the Sardinians were driven successively from their position at Ceva, and from that which they occupied subsequently behind the Corsaglia river, as well as from the position of Mondovi, on the 18th and 22nd of April, and were obliged to retreat towards Turin.

Hitherto, it had been necessary to preserve the communication of the French army with Nice by the circuitous route of Savona, but as soon as the Sardinians retired from Ceva, it became possible to adopt a far shorter line to Nice by the Ponte di Nava pass. The French army advanced in pursuit of the Sardinians, and on the 23rd of April Napoleon received overtures of peace from General Colli. Napoleon's reply was that France was as desirous of peace as Piedmont, but, inasmuch as any treaty which he might enter into must be ratified at Paris, he would consent to an armistice, on condition that the three fortresses of Alessandria, Tortona, and Coni, together with the citadel of Ceva, should be delivered up to him, as he could not be expected to consent to lose the fruits of all his victories without some material guarantee. But, as time was all important, he

continued his advance upon Turin while waiting for the acceptance of his proposal. It was, indeed, not to be expected that the Austrians at Acqui could remain passive spectators of the march of their common enemy upon the capital of their ally; but Beaulieu did linger so long at Acqui, that the movement which he at length made for the purpose of joining the Sardinians was too late to be of any use.

On the 25th of April the French troops occupied Fossano, Cherasco, and Alba. One division was on the right in observation of Beaulieu towards Acqui. The acquisition of Cherasco was of great importance to Napoleon, as it gave him possession of a fortified place, which, by means of its own magazines, he could place in a complete state of defence. The position of the French army at Cherasco enabled them still further to shorten their line of communication with France, by adopting the more direct route of the pass of Tenda. On the 25th of April, Beaulieu did at last make up his mind to endeavour to join the Sardinians, and he marched for that purpose as far as Nizza, en route to Alba, but he was too late. On the 26th, the French troops crossed the Stura, and continued their advance upon Turin. On the 27th the Sardinian General Colli signified to Napoleon the acceptance by the Court of Turin of his proposal for an armistice. On the 28th was concluded the armistice of Cherasco, which terminated the first part of the campaign of 1796.

In considering these operations, two capital faults were committed by Beaulieu. First, the advance of the Austrian centre and left to Montenotte and Voltri respectively was at variance with all military principles; because those two portions of the Austrian army were debarred from all commmunication with each other by the French troops interposed between them, and in consequence of the absence of communication they could not concert a simultaneous attack. If Beaulieu's scheme failed, then in order to restore the communication between his left and centre, his left must retrace its steps by the circuitous route of Bocchetta and Masone, and, long before it could arrive to the support of its centre, that centre might be overwhelmed, as indeed it was, by the superior numbers of the French. Had it been possible for Beaulieu to receive correct information of the real state of affairs; that is to say, had he known that his centre was in danger of being surrounded and destroyed, and that only one French division, instead of all the French army, as he supposed, was between him and Savona, he would have forced his way on the night of the 11th at all hazards, and following La Harpe, he might have arrived at the scene of battle on Monte Legino in sufficient time to turn the scale against the French: or, failing that, he might have seized Savona, which would have interrupted the French communications with Nice, in which case prudence would have obliged Napoleon to regain his communication with that place as speedily as possible; but in war the absence of correct information cannot be compensated by any superiority of force.

The other serious fault committed by Beaulieu, was in delaying to join the Sardinians when they were retreating on their capital. The combat at Dego was fought, and the retreat of the Austrians to Acqui took place, on the 14th of April; the French did not enter Cherasco until the 25th, eleven days later. If Beaulieu had united every available man of his own

force with that of Colli behind the Stura, so late as the 24th, he would still have been in time. If compelled to abandon the line of the Stura and to retreat upon Turin, the advance of Napoleon should have been disputed inch by inch, and as they approached that capital a rapid march of the Sardinian force of 20,000 men, commanded by Prince Carignano, to join Beaulieu and Colli, must have sufficed to crush the French. If Beaulieu had thus acted, although he might have failed to protect Turin, he would still, in all probability, have preserved his ally; and the Piedmontese fortresses, in place of serving as so many strong points of support for the French line of operations, subsequently, on Milan and Mantua, would have continued to hold hostile garrisons, the reduction of which would have occupied Napoleon sufficiently long to give time for the arrival of Austrian reinforcements.

The advantages which the French obtained by the Treaty of Cherasco were as follow:—First, they were dis-embarrassed of the Sardinians; Secondly, they obtained the fortresses of Alessandria, Tortona, and Coni, and the citadel of Ceva, which served to strengthen their base of operations, for their contemplated advance on Milan and Mantua; Thirdly, they were enabled to shorten their line of communication with France by one-half, in accordance with the provisions of the treaty. Instead of proceeding by the circuitous route of Tenda and Nice, it now became direct by Susa and Mont Cenis to Chambery—the advantage of which may be appreciated by this consideration; the battle of Millesimo took place on the 13th of April, and the armistice of Cherasco was not concluded until the 28th, fifteen days later: yet Murat, who was despatched with the provisions of the Treaty of Cherasco, arrived in Paris before Junot, who was sent off directly after the battle of Millesimo.

Napoleon's plan was now to drive the Austrians out of Lombardy and across the Adige, and to take up himself a defensive position on that river, which would afford him an intermediate base for future operations against the Austrians, and at the same time cover his conquests in the rear, and his line of communication with France. It is true that the Adige was a long way from France, and it may appear more than probable that, if the French met with any serious reverses in that forward position, the Treaty of Cherasco would have been looked upon by the King of Sardinia as so much waste paper, and the retreat of the French would have been anything but secure. The answer to this objection is that, however hostile in feeling, the Sardinians retained little power of serious annoyance. With their principal fortresses in the hands of the French, the others dismantled, and their levies disbanded, their discontent need occasion no more apprehension to Napoleon than the rattle of a snake that has lost its sting. Piedmont was under the heel of the conqueror. At this juncture the immediate object of the Austrians was to cover Milan. The Mincio may be regarded as their base. If compelled to abandon Milan they had the choice of two roads by which to retreat—one by Pizzighettone and Cremona on Mantua, the other by Lodi, Crema, and Brescia on Peschiera. If they were intercepted on both of those lines, they might still retreat to the mountains of the Tyrol. In this respect they had a great strategical advantage.

Napoleon's general plan of establishing himself on the Adige was divided into two acts: the first was to march on Milan and to organise Lombardy in the French interest; the second was to advance to the Adige. In the execution of the first part of the plan, viz., the march on Milan, the River Po must be crossed, either in the face of the enemy or by deceiving him, and surprising a passage at some unguarded point. In operating from Alessandria the shortest route to Milan was to cross the Po somewhere in the neighbourhood of Valenza; but the road from Valenza to Milan was crossed by several deep and rapid Alpine streams, the principal of which was the Ticino, which would afford the Austrians so many strong positions in which the advance of the French on the capital of Lombardy might be successively disputed. Immediately after the conclusion of the Treaty of Cherasco the Austrians withdrew across the River Po at Valenza, breaking down the bridge at that place.

On the 5th of May the French head quarters were at Tortona, and the different divisions of the French Army were thus disposed: Serrurier's division was on the left, between Alessandria and Valenza; the division of Massena was at the confluence of the Tanaro with the Po; the division of General Augereau was at the confluence of the Scrivia with the Po. They had received orders to collect together all the boats that could be obtained at those points, as if for the purpose of crossing the Po. The division of La Harpe was at Voghera. These dispositions convinced the Austrian commander that the French attempt to pass the river would be made somewhere between Valenza and the mouth of the Scrivia river; and his measures to oppose it were as follow:—The head quarters of Beaulieu, with two divisions, were at Valeggio; the advanced guard of the Austrian army was at Lomello; one brigade was at Sommo; the division of Liptay was on the left bank of the Ticino, observing the Po in front; the Sardinian General Colli, who after the armistice of Cherasco entered the Austrian service, commanded another division at Buffalora.

Napoleon had secretly assembled on the 5th a picked force of 3,000 grenadiers, 1,500 cavalry, and 24 guns at Casteggio, which he designed to form the advanced guard of his army in his intended attack on Piacenza, and the command of this force was given to General Dallemagne. I should have stated that Napoleon in the Treaty of Cherasco had inserted an express condition that the French army should have a right of passage across the Po at Valenza. This condition was inserted expressly for the purpose of misleading Beaulieu, and making him believe that the French intended to pass the river at that point, whereas Napoleon had determined to make a rapid march to his right to Piacenza while the attention of Beaulieu was directed to Valenza, and while his jealousy of that place was further confirmed by the assemblage of the different French divisions in its neighbourhood. He accordingly assembled the advanced guard at Casteggio. Staff officers were sent off, with small escorts of cavalry, to scour the banks of the river, and to collect all the boats that could be found at Piacenza for the passage of the army. On the morning of the 6th of May the movement commenced. The advanced guard under General Dallemagne, accompanied by Napoleon, made a forced march to Castel San Giovanni. During that afternoon and the succeeding night the remaining divisions of the French army broke up from their positions

along the river front, and followed the advanced guard by forced marches, with the exception of the division of Serrurier, which was left between Alessandria and Valenza both to attract the attention of Beaulieu and to guard the French communications.

On the morning of the 7th of May, at 9 o'clock, the movement having commenced on the 6th, Napoleon, with the advanced guard, arrived at Piacenza. The enemy was taken completely by surprise; he had only two squadrons of hussars on the opposite bank to dispute the passage of the French. The regular ferry boat of the town, together with ten large boats which had been seized, sufficed to carry over 900 men at once, and by two o'clock on that day the whole of the advanced guard stood on the north bank of the Po, and a bridge was commenced in their rear. During the afternoon and the evening the divisions of La Harpe and Augereau arrived respectively at Piacenza and Veratto, and immediately began to cross. While they are engaged in this operation, and while the division of Massena is advancing with all possible speed towards Piacenza, I will turn from them to look after the Austrians.

It was only on the morning of the 7th, the movements of which day on the part of the French I have just related, and about the time when the French advanced guard was approaching Piacenza, that the Austrian General, Beaulieu, was informed of the movement of his enemy, and discovered that his own defensive measures opposite to Valenza were useless. He immediately sent orders to General Liptay at Pavia, to hasten to take post between the rivers Lembro and Adda, in order to protect the Austrian line of communication by Pizzighettone and Cremona. The two divisions at Valeggio quitted that place and followed Liptay. The advanced guard at Lomello was ordered to follow the remainder of the army. About midnight on the night of the 7th, General Liptay, coming from Pavia, arrived at Fombio, and he immediately began to fortify the village by loop-holing the houses, barricading the streets, and planting cannon to sweep the approaches. Beaulieu, with one division, encamped that night at Corte Olono; one division of the Austrian army was left at Pavia, and the advanced guard from Lomello was retreating on Pavia.

Early in the morning of the 8th the advanced guard of the French, under Dallemagne, which had crossed the Po on the previous day, advanced to Fombio, and found that village full of Austrian troops. The position of the French was now critical; it was necessary to dislodge the Austrians from the village at once—a few hours delay might bring up Beaulieu with reinforcements, and the small portion of the French army at that time across the Po would have been exposed to fight a battle, with a great river in their rear, without a bridge by which to retreat in case of necessity.

Napoleon accordingly reinforced his advanced guard with every man who had already crossed the river, and Fombio was carried after an obstinate resistance. General Liptay retreated to Codogno, but, pursued to that place, he continued his retreat to the Adda, and crossed that river at Pizzighettone, where he remained. During the afternoon of the 8th both the divisions of La Harpe and Augereau succeeded in crossing the river; La Harpe was advanced towards Pizzighettone. During the night of the 8th, at about 12 o'clock, Beaulieu arrived at Pusterlengo. He first

there learned the events of the preceding day, and found that Codogno was in possession of the French, who were thus directly interposed between him and Liptay at Pizzighettone. He took advantage of the darkness of the night to endeavour to force a passage. The French at first were surprised, and their General, La Harpe, was slain ; but the French fought so obstinately that Beaulieu, unable to force a passage, retreated on the road to Lodi, and he ordered the other divisions of the Austrian army likewise to direct their march upon that place.

During the night of the 8th Massena likewise effected the passage of his division across the Po, and, on the morning of the 9th, the whole of the French army, with the exception of Serrurier's division, was on the north bank of the Po, and the bridge at Piacenza was completed, which secured Napoleon's retreat. On the morning of the 9th the aspect of affairs was as follows :—Beaulieu, with the head-quarters of the Austrian army, was retreating towards Lodi from Pusterlengo; two other divisions of the Austrian army were marching from Pavia to Lodi. The divisions of Massena and Augereau were advancing in pursuit of Beaulieu. One French division remained at Pusterlengo to guard the French retreat on Piacenza, and to observe the Austrians at Pizzighettone. Serrurier was approaching Piacenza. On the morning of the 10th he arrived at Piacenza, and filed across the bridge. He then advanced to Pusterlengo, and relieved the French division which had occupied that place. That division was enabled, therefore, to follow the division of Massena and Augereau. Those three divisions were delayed sufficiently long by the resistance offered by the Austrian rear-guard to enable Beaulieu to reach Lodi with his division, and to cross the river, as well as the two Austrian divisions which were marching from Pavia; but it was so near a thing, that the last division of the two was only filing across the bridge when the French entered the town. The results of the battle of Lodi are probably familiar to you all, and I need not, therefore, dwell upon them in detail. Beaulieu, now cut off from Milan, was retreating upon the Mincio, and his only object in defending the passage of the Adda at Lodi was to enable the Sardinian general Colli, with his division, and coming from Buffalora, to cross the river at Cassano and gain Brescia; and Napoleon's only object in endeavouring to force the passage of the river at Lodi was to cut off Colli from Brescia. This may be said to terminate the second part of the campaign of 1796. The Dukes of Parma and Modena now concluded a convention with Napoleon, and a new element was introduced by him into the practice of forced contributions, viz. the exaction of their choicest works of art for the purpose of embellishing the capital of the French republic.

The interval between the 10th of May and the 22nd was occupied by Napoleon in organising Lombardy on the model of the great French republic.

On the 22nd May the French army commenced its march towards the Adige; the Austrians defended the line of the Mincio, and their position was very strong. Their right rested on Lake Garda, and was defended by a flotilla of gun boats on that lake. Their left rested on the Po; their front was covered by the Mincio, and strengthened by the fortresses of Peschiera and Mantua.

Nevertheless, on the 30th of May the French forced the centre of the Austrian position at Valeggio, and the Austrians under Beaulieu retreated into the Tyrol. Thus terminated the third part of the campaign.

The succeeding month of June was occupied by Napoleon in securing his right flank; and the siege of Mantua was now undertaken by the French. They occupied Verona and Legnago on the Adige, the first possessing three stone bridges over the river, and the last one. Napoleon's object was to secure the right flank of his army from the hostile action of the southern States of Italy, particularly Rome. The French troops now occupied Bologna and Ferrara, and one division, marching through Tuscany, threatened Rome. His Holiness, alarmed, sued for peace, and concluded a convention with Napoleon, by which he bound himself to pay the French 21,000,000 of francs, and to furnish large supplies of horses and provisions to the army, as well as to yield up one hundred of his choicest works of art. It is remarkable that one of the conditions of this treaty was, that the French should have the right of garrisoning Ancona; and latterly some newspapers have expressed surprise that the Austrians should now have gone to Ancona. But the explanation of that measure is, that whoever holds Ancona cuts off the communication by the eastern coast, between Northern and Southern Italy.

On the 29th of June the Austrian army, now under the command of Wurmser, was assembled at Trent, and numbered 65,000 men. It advanced from Trent in two columns: one marched by the Adige, 45,000 strong, commanded by Wurmser in person; the other column, consisting of 20,000 under General Quasdanowich, marched by the western shore of Lake Garda—their design was to unite south of Lake Garda, and, when united, to march to relieve Mantua. But the fatal error of the Austrian plan of operations on this as on all other occasions was, that they advanced to their object by different columns, on different lines of operation, between which no communication could exist. The communication between those two Austrian corps was prevented by Lake Garda, while Napoleon, on the south of that lake, could concentrate his whole force at any point; and he made good use of his central position, first, to attack and destroy the corps of Quasdonowich, and afterwards to turn fiercely upon Wurmser, and defeat him at Castiglione. Wurmser retreated into the Tyrol, and thus ended the fourth part of the campaign.

The Austrians and the French now received reinforcements. Wurmser's plan, in accordance with directions from Vienna, was to descend the Brenta River with one column from Trent, and march by Vicenza and Verona to raise the siege of Mantua. Another column was to march from Trent by the country between Lake Garda and the Adige. This attempt also failed in consequence of the adoption of a double line of operations by the Austrians. No sooner did Wurmser quit Trent and commit himself upon his march down the Brenta than Napoleon directed the mass of his force against Davidowich at Roveredo, and drove him back beyond Trent. Then, leaving one division to observe him, he followed Wurmser down the Brenta, overtook and defeated him at Bassano, and drove him in the direction of Vicenza; and here he would have been completely destroyed, but that the French garrison of Legnago, owing to some misconception, had withdrawn, and Wurmser was enabled to cross the river Adige in

safety and take refuge in Mantua. The Austrians now had one marshal and 24,000 men inclosed in Mantua. This terminated the fifth part of the campaign.

The sixth part of the campaign commenced in this way. On the 1st of November the Austrian Marshal Alvinzi with 40,000 men advanced from the Piave river towards the Adige, while another column under Davidowich, consisting of 18,000 men, advanced from Trent; and here was the error again repeated of a double line of operations. 24,000 Austrians were blockaded in Mantua. Napoleon had only 30,000 men at his disposal: 8,000 were blockading the Austrians in Mantua; and he could not raise the siege of that place, as, by so doing, he would have set free 24,000 men. He therefore was obliged to blockade it. With 18,000 he endeavoured to cover Verona from the advance of Alvinzi, while 4,000 guarded the approach from the Tyrol in the strong position of Rivoli. By the victory of Arcola he rid himself of Alvinzi, and terminated the sixth part of the campaign.

Early in January of the succeeding year a third attempt was made by Alvinzi to relieve Mantua on two lines. The principal attack was made by Alvinzi from Trent upon Rivoli. A secondary attack was made by Provera from the Brenta upon the Adige. Napoleon employed a small force to defend the passage of the Adige against Provera, while he concentrated the greater part of his troops against Alvinzi, whom he defeated at Rivoli; and the memorable victory of Rivoli terminated the seventh part of the campaign. As the consequence of this victory Mantua fell; and the campaign of 1796 may be considered to have been terminated by that event.

CHAIRMAN.—I think we can have but one feeling of regret, and that is, that the time has not been a little longer. We must all of us, I think, have been struck with this fact, viz. how thorough a master of the subject our friend is, and how clearly he has described to us military operations of excessive complication, but which, I am quite sure, have been made to the minds of all of you as clear as possible.

Friday, May 27th, 1859.

Colonel the Hon. JAMES LINDSAY in the Chair.

THE APPLICATION OF STATISTICS TO NAVAL AND MILITARY MATTERS.

By W. Farr, Esq., M.D., F.R.S., &c.

§ I.

If a discovery is made in chemistry—if a new power, such as steam, is created—if new arms are invented—if new systems of preserving health are discovered—military science naturally endeavours to turn them to account; and often succeeds to an extent which the inventors never anticipated.

It was, I apprehend, from a belief that the field of statistics might contain materials of value in a military point of view, that the Council of this admirable Institution requested me to deliver a lecture. And I hope to be able to show that, however wrong they were in the choice of a lecturer, they were right in the selection of a subject.

Statistics is almost a new science. Its name is scarcely understood; yet it has been prosecuted diligently for many years. A great number of facts has been collected, and new methods of inquiry have been instituted. The Census supplies information about the population of these islands in the present time; and thus it furnishes some indications of the resources and the strength of England. The wealth of the country—its sinews of war—has also been investigated. The means of determining the loss of life under different circumstances are known; and many of the causes of sickness and of death are understood. Financial statistics, and all the methods of estimating and of checking expenditure, have made immense progress since the last great French war.

Numbers enter largely into the striking results of war; they run through all its combinations; victory, liberty, the happiness of families, and the fate of nations, often depend upon subtle calculations.

I propose to pass rapidly in review some statistical facts, which may probably be turned to account by some of you, in increasing the power and in developing the defences of this country.

Military statistics deal with the sea and the land forces. The land force consists of the standing army, in the first place; and, in the second, of the yeomanry, militia, and volunteers, which may be either a regularly disciplined force, or a large temporary levy of the fighting men of the nation.

Adam Smith, in one of the ablest chapters of the "Wealth of Nations,"* shows that "a well-regulated standing army is superior to every militia." And, undoubtedly, if the choice lay between these two institutions, it must fall on the standing army; to which the facts I shall have to discuss will refer. But the two systems of defence are required; and the utility of the combination of a standing army—of a military profession—with a well-organised militia, is established by experience, and by the highest military authorities. By the combination, many of the advantages of both the systems are realised, and the evils of a large standing army are avoided. The militia is, says Jomini, the auxiliary of the army on great occasions; and this simple institution, which places all the fighting men of a nation in local reserves, and in battalions ready organised, partly trained, and acquainted with the use of arms, admitting of development in proportion to the dangers of the country, is certainly as suitable to the character of the English as it is to the character of any other nation.† It is an old English institution; and our Census shows to what extent it can be developed to meet the exigencies of the times.

The militia was almost extinct at the time of the Census. I say nothing of the non-effectives, which amounted to 83,797 in the year 1851, when the effectives were 178,773, making the army and navy 262,570 in the aggregate, of which more than two-thirds were serving. And I omit all the forces in the service of the East India Company; the European part of which would raise the effectives of that year to about 203,807.‡

The following are some of the statistical characteristics of the army and navy. They show how the military differ from other professions. I refer to tables in the Census Report (1851) for the facts.§

(1.) These professions are followed by men only.

(2.) They are followed by men of certain ages; and, although a few are in the returns under 20 and above 40 years of age, the great bulk of the men are of this age, which may be called the athletic age. "It is the age of early manhood. The growth is then completed; weight, stature, and strength are at their maximum." Of 178,773 effectives,

MALE POPULATION of UNITED KINGDOM and ARMY and NAVY at DIFFERENT AGES.

Age.	Male Population of the United Kingdom, 1851, at six different ages.	Army, Navy, and Marines, belonging to the United Kingdom, 1851.
10	1,600,554	879
15	1,494,019	17,351
20	1,268,129	62,364
25	1,084,332	48,282
30	939,525	28,382
35	818,460	13,399

* Book v. ch. i. part 1.
† Jomini, vol. i. p. 222.
‡ Census, 1851, Occupations, &c., vol. i. p. cccli.
§ Ib. vol. i. pp. ccexlv-viii.

including officers, 8,116, or only *one* in 22, were of the age of 40 and upwards; 299 were of the age of 60 and upwards.

(3.) Their numbers fluctuate to an extent unparalleled in other professions. Since the Revolution, the sea and land forces have so fluctuated, as to range from a given number in time of peace to *four* times that number in war, and shortly after the peace back again to the original number.

(4.) *They are unmarried* to an extent of which there is no example—at the corresponding ages—in other professions. At the age 20–25, *twenty* per cent. of the civil population are married. At that age 4 per cent. of the officers of the army, 2 per cent. of the officers of the navy, 5 in 100 soldiers, 6 in 100 seamen, are married.

At the age 30–35, *seventy-one* per cent. of the male population are married; of officers *half* this number, or 35 in the army, 44 in the navy, are married; of the soldiers 28, sailors 47, are married.

Officers in the army marry in larger proportions after the age of 40, but never in the same proportion as men in other professions; after the age of 40 however naval officers excel other professions in this line; from 78 to 84 in 100 of them are living in matrimony at the age 40–60.

Sailors of 45 marry to nearly as great an extent as other professions; the soldiers reach this haven later, so that at 50 and upwards an unusual proportion are married; of the conjugal condition of the ineffectives we have no information.

(5.) The mortality of the army is at the rate of 32 in 1000 in time of peace.* It was, excluding officers, at the rate of 56 in the last French war. The mortality of the civil population at the corresponding ages is at the rate of 9 in 1000. The excess of the mortality in the navy was formerly as great; it is at present much less.

(6.) A considerable part of the excessive mortality is the result of defective sanitary arrangements at home and abroad, and a part is also referable to climate, for it is one of the characteristics of our military force that it is in a state of perpetual movement. In 1851, of the Queen's army, 66,424 were at home, 76,446 were in the colonies, in India, or on the passage out or home.

(7.) The regular forces of a country may consist of foreign troops, or of natives; and, as every great country contains more than one race, the constituent ratios of the several races may differ. England contains men of Irish, Welsh, and Highland blood, as well as Anglo-Saxons and Normans. It is a mistake to talk of us as simple Anglo-Saxons. The English army, like the nation, is a fusion of all these kindred races. The numbers born in England (67,647) are nearly equal to the numbers born in Scotland (15,300) and Ireland (53,169) together (68,469); of the officers, 4,000 were born in England, 836 in Scotland, 1,670 in Ireland. Only 6,754 men of the English army had foreign birthplaces. The royal navy contains few Irishmen; of 35,903 seamen and marines, about 23,401 were of English, 9,466 of Scotch, and 3,036 of Irish birth† Taking these numbers, there were enrolled in the regular forces 91,048 Englishmen,

* Mortality of British Army, p. 10.

† Estimated from the Returns of Seamen, Census, Occupations, &c., vol. i. p. cccli. Proportions: English ·66; Scotch ·26: Irish ·08.

56,205 Irishmen, 24,766 Scotchmen, and this is in the order, but not in the proportion, of the three populations. England, Wales, and the Channel Islands contributed 50 in 10,000 of their population; Scotland 85; Ireland 86; the United Kingdom, which, for the sake of brevity, may be called England, 62 in 10,000 of the population. There is sufficient variety to supply the peculiar qualities suitable to cavalry, infantry, and artillery on land, and seamen on the ocean; while all races, speaking one language, enjoy the same rights, and are indissolubly united by past victories and present liberties. The population of none of the great powers—nay not of France herself—has a firmer solidarity.

Now it follows, as a necessary deduction from what has been said, that the ARMY *and* NAVY *are* NOT SELF-SUSTAINING, and, if they were not constantly recruited from the other professions, the race of British warriors would become extinct. The families of other professions reproduce themselves, and are constantly increasing at home, as well as sending out swarms of emigrants abroad. But it is evident that, if the mortality of the army be undiminished, though the soldiers brought up as many children as the men of other classes—which could only be the case if *four times* as many were married as are married at present—the sons would never equal the fathers in number. Judge then of the state of things under the existing system. Officers cannot often be the sons of officers; soldiers are not the sons of soldiers.

This makes recruiting, which in other professions goes on of itself, a problem of vital interest in the army. It is a difficulty which meets you at the threshold.

If you look into the system of recruiting in other professions, you will see how this difficulty, and another almost equally great, are overcome. The landed gentry do not die out. The troops of artists, clergymen, lawyers, and physicians are easily kept up; the sons always equal the fathers in numbers, and, should the supply fail, the sons of other classes always flow into the ranks. These professions offer honourable and, on the whole, attractive occupation to men. But take other classes: the 159,073 tailors are maintained without any difficulty; the sons replace the fathers. The 282,897 shoemakers are never at fault for successors; the sons replace the fathers. And if there is an extra demand in any of the trades, a rise of wages soon draws into the ranks the required number of the sons of other artizans. The great army of 659,765 farmers, and their men 2,146,936 strong, gets its recruits silently; for the sons replace the fathers.

In this kingdom there are now more than 301,253 miners. The occupation is by no means attractive. It is hard, dirty work, pursued under ground. You see the collier at the coal seams nearly naked, covered with perspiration, in his ordinary employ. The danger in many mines is great. The men are knocked on the head by the fall of coals; they are often burnt; or they are blown up in great numbers. The mortality of miners from violent deaths alone in Staffordshire and in Wales is at the rate of 8 in 1,000 annually:* in Cornwall the mines are so badly ventilated,

* The army at home and abroad lost less than 7 in 1,000 by injuries in action during the wars, 1793—1815. See two excellent papers, by Mr. Hodge, in the Journal of the Statistical Society, vols. xviii. xix.

that the constitution of the men is destroyed in early life. The miners are nevertheless recruited without difficulty. The wages are 8*s.* 4*s.* 5*s.* a-day in Staffordshire, and the men work five days of the week. They marry young in great numbers, and bring up to their business sons whom they send down to the work early in life; you will see how early by this statement:—

	Aged 10—	Aged 15—	Aged 20—	Aged 25 to 30—
Miners . .	35,518 . . .	51,064 . . .	51,302 . . .	40,398

I met in the districts boys who had lost their legs, and been otherwise mutilated in the mines.

Upon asking an excellent man in Staffordshire, who had many boys in his employment, why they were sent down into the pits so early, he replied:—"Unless they go down at an early age, they will not go down at all."

In all disagreeable trades, the wages are raised; the families are multiplied, and the boys are sent to work at an early age by their parents: for boys do not really choose their profession; it is chosen for them. The agricultural and mechanical occupations of the country are all entered before or shortly after the age of 15. So that when you ask for recruits for the army later in life, you ask them to leave some other profession. The country, with its vast dependencies, requires a regular force for its defence. Whether the strength should be 100,000 or 200,000 officers and men, is it not desirable that the class should breed a considerable number of its body? Valour is transmissible. This is an elementary principle in physiology.

> Fortes creantur fortibus et bonis:
> Est in juvencis, est in equis, patrum
> Virtus.

A perpetual class of men is required: by removing the obstacles to marriage, lightening the lot of soldiers' wives, and facilitating the education of their children, you sustain their numbers in the most natural way.

We know what encumbrances—real *impedimenta*—wives and children must be in a moveable force. But human passions cannot be suppressed; soldiers have their affections like other men. And if they have not wives, other women we know surround all camps. Half the sickness probably which disables so large an amount of our forces at home springs from such sources; and it unfortunately happens that the children of the "black-eyed Susans," and of the "girls left behind him" by the soldier, die in wretchedness or live fatherless.

Enforced celibacy in any *large class* necessarily undermines public morals; and ends in the destruction of States. The Romans, after their eastern conquests, expressed a general disinclination to marriage. The Senate in vain passed marriage laws; in vain Augustus reproved and exhorted his officers to marry, and perpetuate the Roman name. The women, descended from the Lucretias of the Republic, became the Messelinas of the Empire; and the legions, having died out, had to be replaced by the descendants of those virtuous Germans celebrated by Tacitus.

Upon all these grounds the restraint of marriage in standing armies appears to be impolitic; it produces disease, it forces corruption, and it cuts off a natural supply of recruits.

Under any circumstances however, a large portion of the recruits must be drawn from the general population. And it is evident, from what has been said, that recruiting is easy in proportion as you take boys at the early ages. There were 1,268,129 men in 1851 of the age of 20 and under 25, of whom 62,364 were in the army and navy. There were 1,494,019 boys of 15 and under 20 in the kingdom; and if the analogy of the mining class were followed, an equal number of them would be enrolled. That is, if you had 62,364 soldiers of the age 20-25; you should have 62,000 soldier-boys. But "boys are unequal to all the duties." Undoubtedly. All our industrial operations are now scientifically subdivided; and thus a part of the processes is performed by the most skilful men, a part is performed by machinery, a part by brute muscular force, and a part is performed most effectively by boys. In Staffordshire, the labour of the young hands is highly valued; at the age of 15 they get 2*s*. a-day, five days in the week.

The dexterity necessary for delicate mechanical operations is acquired early, before the bones are thoroughly set, and the development of the muscles is completed. No one can learn to handle a tool well unless he take it up early. The fiddle cannot be played by people who have not practised from childhood. And do not the arms of the present day require in use a quickness of the eye and a precision of the hand which nothing but early training can impart? You have the great divisions of the army into officers and men, as well as into the different arms; and it is a question for military art to decide whether, by some further subdivisions, profitable employment may not be struck out for boys of 15; although the main work may still be performed by men.

In the merchant service there were 30,987 boys of 15-20, to 39,888 men of 20-25; in Her Majesty's navy, the boys of 10 and under 20 amounted to 5,225, while the men of 25-30 were only 5,567. Probably more able seamen are formed by this arrangement than would be obtained by taking them at 18 into the navy. The majority of our unmatched seamen must have gone to sea as boys, and is it not certain that if the army were entered at the same age the men would attain the same marvellous efficiency?

You have the recruiting of the peace establishment, and you have the recruiting of the forces when the country is at war with France; the wars with other powers being always of comparatively small dimensions. What force can this country raise? We have the analogy of 1811, when the power of England was fully developed; and if we assume that the forces raised should bear the same proportion to the men of the age of 20-40 as they bore in 1811, then the numbers would be 817,229 men.

This was the nature of the force in 1811:

SEA and LAND FORCES of the UNITED KINGDOM.

(See Registrar-General's Sixteenth Annual Report, Appendix, p. 123.)

		Proportion in 1811 to 100 Males living, aged 20—40.	Military and Naval Forces in in 1811.	Military and Naval Forces in 1859, if the Numbers were in the same proportion to the Males aged 20—40 as in 1811.
Sea and Land Forces . . .	(1)	19·5	501,488	817,229
Navy—Seamen and Marines .	(2)	5·3	136,778	222,895
Army—Cavalry, Infantry, and Artillery	(3)	14·2	364,710	594,334
Army and Navy:—				
Native Force	(4)	17·2	441,603	719,640
Foreign and Colonial Force .	(5)	2·3	59,885	97,589
Army:—				
Regular Force, Native and Foreign	(6)	10·7	276,189	450,080
Regular English Force . .	(7)	9·1	233,686	380,816
Royal Troops in India . .	(8)	1·2	30,253	49,300
At home and abroad (exclusive of Forces in India) . .	(9)	7·9	203,433	331,516
Embodied Militia . . .	(10)	3·5	88,521	144,254
Foreign and Colonial Troops .	(11)	1·6	42,503	69,263
„ „ Seamen .	(12)	·7	17,382	28,326

(1) = (2) + (3) (3) = (7) + (10) + (11) (6) = (7) + (11)
(1) = (4) + (5) (4) = (2) + (7) + (10) − (12) (7) = (8) + (9)
(1) = (6) + (2) + (10) (5) = (11) + (12)

It will, I believe, never be wise to embody such a number of men, but *it is in the country*, and, if required, can be produced as easily as the force in 1811, either as a volunteer force, a militia, or a regular force.

§ II.

The power of this country at any given time depends upon the genius of its commanders, the skill of its officers, and the courage and character of its men, more than on the numbers of its population; but, other things being equal, population and power increase together. I will now trace the development of this force. Julius Cæsar first landed in Britain with 12,000 men, and was glad with his fortune to disembark. In his second descent he had 2,000 horse and 5 legions. The Roman

army which conquered Britain was composed of some 50,000 men, and the mutual dissensions of the natives facilitated the conquest. Harold had at Hastings about 60,000 infantry; William fought with the same force, but it consisted of the three arms, and had its due proportion of cavalry and archers—the artillery of that day. After the Conquest, the kingdom was held securely; there was a baron, or military chief, and a strong post in every manor of the country, surrounded by, perhaps, 60,215 knights, in the possession of as many portions of territory. The population of England at that time has been estimated at *two millions*.*

By the Statute of Westminster (13 Ed. I.) every man between the ages of 15 and 60 was to be assessed and sworn to keep armour to the value of his lands and goods. These were the fighting men. Boys of 15 were then accounted fighting men. But this force was only called up for short times, and the feudal service was limited to *forty* days, beyond which the knights could only be retained by their own consent, and at the king's expense. The bow-men, like Robin Hood's men, often owned no fees, and owed no service.

Edward III. in his great wars with France first tried two campaigns with mercenaries in Flanders. His attack failed completely, and he incurred large debts. The population of England and Wales amounted then to about 3,000,000. After the English had destroyed the French fleet, he collected a force of 30,000 men, and landed at the Hogue on July 12th, 1346. Normans, Saxons, and Celts were blended together: for that force consisted of 4,000 men-at-arms (Normans), 10,000 archers (Saxons), 10,000 Welsh infantry, and 6,000 Irish soldiers. With this army the battle of Crecy was fought, and the glorious victory consecrated the fusion of the races. Mr. Hallam remarks:—"Edward III. and his successors, in their long contention with France, resorted to the mode of recruiting by contract with a man of high rank or military estimation, whose influence was greater probably than that of the Crown towards procuring voluntary enlistment. *The pay* of *soldiers*, which we find stipulated in such of these contracts as are extant, *was* EXTREMELY HIGH, *but it secured the service of a brave and vigorous yeomanry*." The population of England further increased, and Henry V. levied an army and landed in Normandy on August 1st, 1417, at the head of 30,000 men, namely, 6,000 men-at-arms, and 24,000 foot, mostly archers. With this force, reduced to about 9,000 by dysentery, the battle of Agincourt was fought on October 25. In the following year he landed in Normandy at the head of 25,000 men, which was reinforced by 15,000, making 40,000 in the aggregate. In 1421 he levied a new army of 24,000 archers and 4,000 horsemen. These armies gave him the daughter and the crown of France.

Machiavelli deduces this lesson from our history.† "There is nothing more certain than that, where men are unapt for war, the fault is in the Government; of which," he says, "we have a fresh and memorable example. There is scarce anybody ignorant, that of late years the King of England invaded France, with no soldiers but his own people; and yet, though England had had no wars for thirty years, and had neither officer

* Census, I. Report, lvii. † Discorsi, i. 21.

nor soldier who had ever seen a battle, he ventured to attack a kingdom full of officers and good soldiers, who had been under arms for several years together in the Italian wars. This proceeded from the prudence of the Prince, and the excellence of the Government, in which, *though in times of peace, the exercise of arms is not intermitted.*"

The army was a militia: yet the victories were not accidents. The order of battle—the same at Crecy and Agincourt—was, it is said, an improvement on the formation of Hannibal at Cannæ: the conduct of the kings in command and of the troops was excellent; and the archers had had bows in their hands from boyhood. They did not begin to use their weapons for the first time at the age of twenty.

The "fighting men" were enumerated in Elizabeth's reign, and amounted in 1583 to 1,172,000, which would imply that the population was about 4,445,400. All the seamen in England amounted to 14,000; the land forces amounted to 79,000, at the time of the Armada.

Up to the reign of her successor, Scotland was frequently at war with England. Next to France, she was the most constant adversary. The King of England—

> Never went with his forces into France,
> But that the Scot on his unfurnished kingdom
> Came pouring, like the tide into a breach.*

The crowns were united in James; and the population of England, about 5,466,000 in 1651, became 6,378,000 by conjunction with Scotland; but in this year of Cromwell's "crowning mercy," that country was garrisoned by his troops. The union was in fact first completed by the genius of Chatham, who placed arms in the hands of the Highlanders.

Blake, in the command of thirty ships, entered the Mediterranean Sea, where no English fleet, "except during the Crusades, had ever before sailed." And the army "never failed to destroy and break to pieces whatever force was opposed to it."† Under Turenne, the English troops beat the famous Spanish infantry, and took Dunkirk. The army which proved invincible was not large; but it had a peculiar character. "*The pay of the private soldier was much above the wages earned by the great body of the people;* and if," says Macaulay, "he distinguished himself by intelligence and courage, he might hope to attain high commands. *The ranks were accordingly composed of persons superior in station and education to the multitude.* These persons, sober, moral, diligent, and accustomed to reflect, had been induced to take up arms, not by the pressure of want, not by the love of novelty and licence, *not by the arts of recruiting officers*, but by religious and political zeal, mingled with the desire of distinction and promotion."

The army and navy assumed unusual dimensions during the reign of William III.; 40,000 seamen and 87,702 men under the head of land forces, were voted in 1694; and as supplies, £2,382,712 were voted for the navy, £2,500,000 for the land forces. While the seamen remained at 40,000, the land forces voted during Marlborough's campaigns were, on

* Shakespeare, Henry V. Pope Martin V. said: "In truth the Scots are the only antidote of the English."—P. Hist. of Eng. ix. A.D. 1421.

† Hume; Macaulay.

an average, 50,000, and never exceeded 65,210. The British force at Blenheim did not apparently exceed 9,000; and throughout the war, their "valour and order" appear to have been more striking than their numbers. "The troops," Marlborough writes in 1708, "are in so good a condition that it would gratify your Highness to see them."*

The power of England increased slowly, and after the peace of Aix-la-Chapelle, in 1751, the population was about 7,392,000. In that year Clive marched from Madras at the head of 200 Europeans and 300 sepoys to Arcot, and the English became subsequently masters in India. The seven-years war followed, in which Prussia, allied with England, fought France, Austria, and Russia; and Spain also engaged in war against England. 70,000 seamen, including 19,061 marines, and a land force of 77,046, in all 147,046 men, were voted; the supplies for that year (1761,) were £3,912,226 for the navy, and £1,793,033 for thea rmy. The naval force of England was chiefly engaged; but Wolfe's victory led to the cession of Canada by France, and of Florida by Spain, at the peace of Paris in 1763. The after-loss of the American Colonies—the cession of Florida and Minorca to Spain, of Senegal and the French East Indies, were the result of the great war with the United States, France, Spain, Holland; and of the armed neutrality. The population at that time could scarcely sustain the position England had attained. The new manufacturing arts, and the mines, created a demand for skilled labour; wages rose, and the army low pay drew only an inferior class of men into its ranks. Their inferiority in the use of projectiles, which had been the glory of English troops, was evident in the American war, and in the early wars of the French Revolution, where ignominious failures were not wholly the fault either of incapable generals, or defective sanitary measures.

That the people of Ireland were alienated from England by commercial jealousy and bigoted intolerance, we are reminded by such events as the battle of Fontenoy, the Irish volunteers, and the Rebellion of 1798. The Union did something to heal the breach in 1801, and the good work has since been completed. The population of the *United Kingdom* amounted at the Union to about 15,957,000, and it grew during the ten years of war to 18,221,000 in 1811.

To recapitulate: when Edward III. invaded France, he had about 3,600,000 subjects, English and Irish. When Queen Elizabeth encountered the Spanish Armada, she was at the head of 5,000,000. When Cromwell asserted the power of England in Europe, and Blake's flag swept over the Mediterranean, of the 7,470,000 people in these islands, 2,000,000 at least in Scotland and Ireland were hostile to the Government. George III. in the war which the great Chatham directed, drew his forces from 9,742,000; and now Queen Victoria reigns over 28,000,000 people, of whom 4,238,000 are of the military age; or if you go back to the age of 15, and take the old definition, 8,000,000 are fighting men. On the standard of 1811 she can cover the seas and maintain in the field for many years a force of *eight hundred thousand men*. I leave out of account the force of the Colonies and India.

The population of the other great powers of the world has also rapidly increased: Russia has conquered all the parts of the Northern hemi-

* Despatches, vol. ii. p. 243, June 11, 1708.

sphere except the valiant states of Sweden, Norway, and Denmark. The great powers of Prussia and the United States of America have increased more rapidly than England. The population of France was to that of England as 27,000,000 to 16,000,000 in 1801; it is now as 36,000,000 to 28,000,000. These numbers are nearly as 17 to 10, and 13 to 10 respectively. France, notwithstanding the great outlet for population in Algeria, has seen little increase of her children recently; and in 1851 the number of English children under five years was greater than the number of French children. Frenchmen of the age 20-25 are now nearly 1,523,000, and Englishmen of that age are 1,508,000. The numbers at the conscription age are nearly equal. So much for the power of England estimated in men.

---

§ III.

I have now to notice some points in war finance, which can be illustrated by statistics.

Adam Smith lays it down that "*the whole army and navy are unproductive labourers.* Their service," he says, "how honourable, how useful, or how necessary soever, *produces nothing* for which an equal quantity of service can afterwards be procured."

What have we to say in reply? Shall we enumerate the glorious victories which illustrate English history? Unfortunately political economists see few charms in military glory. They count the cost, and remind us of the destruction of property and life in war.

Shall we enumerate the British possessions which have been acquired by the vigour of successive Governments and the valour of the army and navy? British North America, the West India Islands, the fortresses in the Mediterranean, the islands in the Atlantic, the points on the west coast of Africa, South Africa, the small islands in the Pacific, New Zealand, Australia and its gold mines, Hong Kong, India—making 7,895,000 square miles of territory, some of it fertile in the highest degree. That is something solid. But *colonies do not pay*, exclaim the economists. They will not pay even for their own defence. The American colonists began a great war with France, and *rebelled, because they were called upon to pay a fraction of the costs.*

Upon looking at the matter more closely, it can however be demonstrated, upon the principles of political economy, that a defensive force is productive in the true sense of the word. Take the navy. The seas are now covered with British merchandise. In the trade-returns, the value of the exports is set down at £126,000,000; the value of the imports at £192,000,000.* Ships are insured, and the other day the mere rumour of war raised the rates of insurance. Insurances, Chalmers says, were never, except in peace, made on such reasonable terms as in the last war—"*after the capture of the enemy's corsairs and the ruin of his fleet.*" Insurances, I suspect, would run up now very rapidly, if England had no fleet. Perhaps some of the powers which have fleets might find out satisfactory reasons for sequestering our merchantmen: and if all nations suppressed their fleets, the

* £4,508,000 transhipped appearing in both.

seas would be covered with swarms of pirates. The insurances to cover losses would then exceed the expenses of an adequate navy preventing losses, if trade were carried on; but trade would be, in such a state of things, impossible.

It is not an easy matter to estimate the value of property in the United Kingdom; but if we capitalise the value of the labour, and include the property, it cannot amount in the aggregate to less than £10,000,000,000; and the value of the annual produce probably exceeds £400,000,000. The possession of that property is secured against foreign aggression by the army and navy. The property is now insured for £48,000,000 a-year, including the charge on the war debts, that is, at a premium of *five farthings* on the pound, or a little more than 12 per cent. on the produce.

The British dominions abroad, exclusive of India, are *fifty-five* times as great in extent as these islands. What the value of the property is to the colonists, I do not pretend to determine; but if the protection of the British flag were withdrawn, colonial property would be in imminent jeopardy; and it owes its security to the army and navy. England protects her colonies, almost as a father protects his children at her own expense. Some of them are approaching, and will, we may hope, soon attain, their majority. They will be able to defend themselves, with some assistance in extraordinary emergencies.

Labour is required to create property; and property loses all its value if it is destroyed. The labourers require protection in carrying on their work; and the owners must be secured in their possessions. This service is absolutely required; it is therefore obtained, and paid for like other labour, which is of no more than equivalent value. Any expenditure on an army exceeding the sum required to secure the life, property, and freedom of the people, is, I admit, entirely unproductive; and this view deserves the attention of the continental monarchies.

It is then evident that as much military force as is required to defend a country is productive; and the value of the product is expressed economically by *the rate of insurance indispensable to maintain the security it affords*. Our forces may be legitimately employed for other purposes than defence against attacks. They may be, in my opinion, employed in the support of any righteous cause which can only be promoted by arms. But England, as Hume acutely remarks, is ever too ready to engage in war, particularly against her great rival; and this is turned to account by continental diplomatists.

In the six wars since the Revolution (1688) England, besides the sums annually raised, contracted £802,000,000 of debt. The amount of the debt is now £803,000,000; the annual charge, £27,412,000. The wars with France last, on an average, 11 years; and the three wars from 1793 to 1815—which were really one—extended over 22 years. Such are the resources of these two great states. The amount of debt contracted in every war increased: in the four last wars the debt contracted was 31, 64, 121, and 529 millions. It was doubled twice, and then quadrupled. I am afraid to announce the next term of this progression. And I hope it is unnecessary; as, if the country engage in a just European war, let us hope that our statesmen will appeal to the patriotism of the people for a large portion of the supplies within the year;

and adopt measures to prevent the waste which was exhibited in raising and expending the public money in former wars. Then England, adopting a wise economy, will meet with no difficulty in procuring the "guineas" which Jomini holds are so great an element of her strength. For she paid for the supplies of her army, not only in Spain, but in France itself; and has yet met every one of her engagements since the Revolution, while the other great powers have several times been bankrupt. France repudiated a great part of her debts five times in that period, and once under Sully. "Thus," says Bresson, one of the latest financial writers, "the public faith has been broken six times in two centuries; each generation has seen a national bankruptcy."* Punctuality in meeting her engagements is the explanation of the credit of England, which some continental writers, strangely enough, regard as a "secret."

War has led heretofore to the greatest waste of the national resources, not, be it remarked, to the profit, but to the loss of the army and navy; and in the last European war immense sums were thrown away. There was no proper audit; and only a very imperfect publication of the accounts, both of men and money. In the present day the financial accounts go a great deal into detail; but, as statistical documents, they are exceedingly imperfect. The items require judicious classification. The number of officers and men voted appears in the estimate, but where is there any account of the men actually serving? The items of income and expenditure appear, but there is an immense durable stock of ships, timber, wares, clothing, forage, barracks, and warlike stores, which never enter into the annual accounts; when this stock is consumed the annual expenditure is apparently low, and we have what the simple call "a model year;" when it is augmented, as in the present day, the expenditure is made to appear higher than it really is. To present a true account, *stock should be taken at the beginning of every year;* and the public accounts would then become reliable statistical documents.

If we divide the total expenditure on the army, navy, and ordnance, in the year 1811 by the mean strength, it is found to be at the rate of £112 a man in the currency of that year, or £97 in gold. The cost in 1851 was nearly at the same rate, £99 per man. Owing to the operations on the stock, the value of which does not figure in the public accounts, the expenditure, £21,143,000, divided by 176,906, the number of men, gives the higher rate of £118 per man for the financial year 1859-60. The expenses of warlike stores, and of their manufacturing establishments, should be distributed equitably between the army and navy; but in what proportions I cannot learn. I divide the expenditure under these heads into two equal parts for the moment; and the figures stand thus, after excluding the troops on the India establishment:—

	Officers and Men.	Expenditure by Estimate.
Army	117,906	£10,678,000
Navy	62,000	£10,465,000

The annual expenditure in the army, including every item, is £91 per man; in the navy, £169. This includes the pay of ineffectives, who are maintained for the sake of the effectives.

* Histoire Financière, par J. Bresson, tome ii. pp. 439–41

A correct statistical account would show the amount and value of every kind of store, and the expenditure per man in the several regiments and ships. The Government could thus exercise an effectual check on the expenditure.

The wages and victuals of officers and men in the navy amount to £56 per man, or one-third part of the aggregate expenditure. To secure their services they are promised half-pay and pensions, which they will one day enjoy; this item of expenditure makes £19 a-head. The ships and establishments cost £64 per head; and this year £16 extra for building and conversion; the warlike stores and their artificers £14 a-year, if half the ordnance charge belongs to the navy.

I wish to direct your attention to two points in *army* finance. The expenditure is at the rate of £91 a man, or, exclusive of the pensions and half-pay, is £72 per man. The pay and money allowances are £32 a man; provisions, fuel, light, clothing, necessaries, £9 a man; barracks £7 a man; equal to £48 a man. This includes officers.

If we separate the officers, their pay on an average is £233 for each officer, exclusive of half-pay and retiring allowances. The pay, allowances, clothing, medical attendance, necessaries, and barracks of the non-commissioned officers and soldiers, amount on an average to £29 8*s*. a-year; add £5 as the equivalent in present pay of the contingent pension, and the soldier's pay is £34 8*s*. a year, or 13*s*. 3*d*. a week. Whether the soldier be inefficient from sickness or natural incapacity, whether he be weak or strong, dull or quick, stupid or intelligent, all the items of expenditure, except pay, must be the same; and in war the losses by the failures and defects of sick, feeble, incapable, unintelligent armies are costly, and may be irretrievable ruin to their country.

The first economy which statistics have shown is practicable in the British army is *economy of life:* the mortality is much higher than the mortality of the civil population at the corresponding ages, not only abroad but at home. The causes are known, and they can often be removed. It is the same with sickness. Of the British army in the Peninsula 9,300 out of 44,500 (21 per cent.) were constantly sick. The mortality in the army of the East was at the rate of 26 per cent. of which 20 per cent. was by disease; the sickness was in the same high proportion. The sickness and the mortality were formerly as high in the navy; they have been reduced at sea, and they can be reduced by land. The statistical labours of Mr. Marshall, Mr. Edmonds, Mr. Hodge, Sir Alexander Tulloch, and Dr. Balfour, and the inquiries which have been conducted by Commissions and Committees, over which Mr. Sidney Herbert has presided with indefatigable zeal, and with remarkable ability, show how the army might be made a comparatively healthy profession for good men in the prime of life.

Great economy in the end will be realised in the army by the introduction of good arms. And our military history shows that still greater advantage will arise from inducing good men to handle those arms; the legitimate inducements being, in this as in all other professions, good treatment and adequate pay. What is adequate pay? I make one or two observations on this matter, because the pay of the army—unlike that of the navy—cannot be regulated by the competition of a convertible pro-

fession analogous to the merchant-seamen. I have several returns of wages; but it will be sufficient to mention that, while the class of labourers earn 18*d.* a-day, or 2*s.*, a large class of miners and artizans gets 4*s.* a-day; carpenters and masons get now 5*s.* a-day at Greenwich Hospital; some of our highest classes of artizans earn 7*s.* and 10*s.* a-day. This is of course exclusive of Sunday. Their work is not always constant, and they get no pensions. Apprenticeships are served in many of these trades; which, as I have shown, are all entered early. Now the pay and treatment which will draw the sons of men of these classes into the army can only be determined by experience. But it appears to me that you will, for the future, have to pitch the pay of officers and men on a higher than the present scale, to compete successfully for the best men in the field; that you must take many boys at ages as low as fifteen; that you must have different classes of men, at different rates of pay; and that you must abolish all such interference with the men as the forbidding to marry, which is, in the eyes of every man, a grievance, and is probably actually injurious in various ways. The army will thus be a profession, honourable down to the lowest ranks; and a prudent father may recommend his son to enlist in the service of his country. You have abandoned the press in the navy; you repudiate conscription; cast to the winds the inveiglements of the recruiting serjeant, which are unsuitable to this age.

Real economy will be consulted by employing the best men in the population, and limiting their numbers. As in the middle ages men covered themselves with armour till they could not fight, so there is a constant tendency now in nations to call out great armies, which they cannot move or maintain in health. It is a species of cowardice. Let us not imitate their example. Queen Victoria, like Alexander, can find soldiers wherever she can find men ; and there are eight millions of them in these islands ; but it is quite certain that if a large part of the population become as familiar with the rifle as their ancestors were with the bow, an army and navy of 800,000 men—the equivalent proportion of the force under arms in 1811—*will never be required in any future war.* Half the number of skilled men will do the work.

The descendants of the small armies of men that won victories under Edward III., Henry V., Cromwell, Marlborough, and Wellington, will always sustain the honour and interests of their country. Give her volunteers, create a militia by all means ; but this country out of its present population can organize such a regular army as will never fail " to destroy and break to pieces whatever force is opposed to it." The flag which Blake hoisted in the Mediterranean will still float over its waters ; and if England cannot preserve the peace of the world, her sword will bring down the scale on which it is thrown by the Queen. The colonies will be defended ; these shores will remain inviolate.

MALE POPULATION of SEVEN GREAT STATES, distinguishing the Numbers living at Five Ages.

(See Registrar General's Sixteenth Annual Report, Appendix, p. 123.)

Years for which the Population in the Table is given.	STATES.	MALES.					
		Total.	0—20.	Military Age, 20—40.	40—60.	60—80.	80 and upwards.
1851	England - - - -	13,587,545	6,417,101	4,111,481	2,245,358	842,624	70,981
1851	France - - - -	17,794,964	6,562,179	5,541,462	4,020,275	1,566,864	104,184
1844	Turkey - - - -	17,533,124	9,361,323	4,784,490	2,448,275	857,013	82,023
1840	Austria - - - -	18,202,631	8,465,132	5,242,611	3,271,212	1,152,356	71,320
1849	Prussia - - - -	8,162,805	3,821,608	2,535,891	1,342,320	462,986	
1855	Russia - - - -	33,448,093	17,858,678	9,127,414	4,670,594	1,634,931	156,476
1850	United States of America (exclusive of the coloured population)	10,026,402	5,114,831	3,160,028	1,339,838	376,427	35,278
	TOTAL - -	118,855,564	57,600,852	34,503,377	19,337,872	7,413,463	

Evening Meeting.

Monday, February 21st, 1859.

Colonel the Hon. J. LINDSAY, in the Chair.

The Chairman announced that Sixteen Members had joined the Institution since 31st January.

LIFE MEMBERS.

Jones, R. O., Lieut. Roy. Eng.
Clinton, H. R., Ens. 71st. Highland L. I.
Young, W. L. M., Commissary Field Train Department.

ANNUAL SUBSCRIBERS.

Kaye, Horace, Ens. 5th West York Mil.
Bussell, W. G. H., Lieut. 23rd R. W. Fus.
Lowe, R. N. C. D.; Bt.-Major Gr. Gds.
Flower, Lamorock, Lt. 3rd R. Surrey Mil.
Beamish, H. H., Comr. R.N.
Moore, G. W., Maj.-Gen. Bombay Army.
Harrington, R. E. S., Lieut. Rifle Brigade
Browne, Henry J., Lieut. 19th Regiment
Mountcharles, Earl of, Capt. 1st Life Gds.
Gilbard, Geo. Jno., Cornet 16th Lancers
Alexander, Jas., Major.-Gen. H.M.I. Forces
Wilson, S. W. F., Capt. 55th Regt.
Napier, Gerard Jno., Capt. R.N.

NAMES OF MEMBERS who have paid increased SUBSCRIPTIONS since 31st January.

Flower, Lamerock, Lieut. 3rd R. Surrey Mil.
Gamlen, C. A. Lieut. h.p. 3rd Pro. Batt.

DONATIONS.

	£	s.		£	s.
Edwards, H. R., Admiral . .	1	0	Clinton, H. R., Ens. 71st Highland Lt. I.	3	0
Pollock, Sir Geo., Gen. G.C.B.	2	0			

PRESENTS.

LIBRARY.

Books.

Sampson Sandys, Esq. Hints on National Defence. Pam. Lon. 1859. *Presented by the Author.*

Catalogue of the Lepidopterous Insects in the Museum of the E. I. Company. Vol. I. Papiliones, Sphinges. 8vo. London, 1857. *Presented by Secretary of State for India.*

The Platoon Exercise for the Rifle Musket: translated into Turkish for the use of the Turkish Contingent, by W. H. J. Lance, Esq., Lieut. 98th Regt., late Capt. Turkish Contingent, Instructor of Musketry 98th Regt. 8vo. *Presented by Capt. Perrott.*

Major G. T. Haly, Madras Army. The Reorganization of the Native Army, Police, &c. of India. Pamp. large 8vo. London, 1858.

Suggestions for the Dress, Camp Management, &c. Pamp. large 8vo. Lon. 1858. *Presented by the Author.*

No. V. Journal of the National Shipwreck Institution, of the 1st July, 1852.
Presented by Walter Hawkins, Esq.

The Crimea, by Col. Jervis; Geological Edition, by W. P. Jervis.
Presented by Col. W. F. Hamilton, C.B., Gr. Gds. in the name of the Sevastopol Model Committee.

Sir Macdonald Stephenson. Railways in Turkey; Remarks upon the practicability and advantage of Railway Communication in European and Asiatic Turkey; with Maps. 8vo. London, 1859. Map of Turkey to accompany the above. *Presented by the Author.*

The Tente d'Abri. By M. Lecompt, Chef. d'Escadron. Translated from the French, with additional Plates and Remarks, by Lieut.-Col. Hallewell. Pam. Malta, 1859. 2 Copies. *Presented by Lieut.-Col. Hallewell.*

Report of the Ordnance Survey, together with Minutes of Evidence and Appendix. London, 1858.

Papers, Ordnance Survey, 30th June, 1857.

Medical and Surgical History of the British Army during the War against Russia in the years 1854-5-6. 2 volumes. London, 1858.

Royal Warrant, 24th October, 1858, and Report of the Committee appointed to inquire into the existing organization of the Commissariat Department, with Evidence and Appendix. 1 vol. *Presented by Col. P. F. D. C. Stuart, Gren. Gds. M.P.*

Royal Society, Proceedings of. Vol. IX. No. 33. *Presented by the Society.*

The Royal Agricultural Society of England, Journal of. Vol. XIX. Part II. No. 42. *Presented by the Society.*

Maps—Plans.

Chart of the Curves of Equal Magnetic Variation, 1858.
Presented by F. I. Evans, Esq., R.N., F.R.A.S.

Plan of part of the Parish of St. Oswald, in the County of Durham; scale, 25·344 inches to a mile. Specimen by Zincography, transferred and printed at the United Service Institution, 4th February, 1859, in illustration of a Lecture delivered by the donor. Three Copies.
Presented by Col. H. James, R.E., F.R.S., Superintendent Ordnance Survey.

Topographische en Militaire Kaart van het Koningrijk der Nederlanden vervaardigd door de Officieren van den Generalen Stafen Gegraveerd op het Topographisch Bureau van het Ministerie Van Oorlog, op de Schaal van 1:50:000. Folio, 21 Plates. Voorschrift ter Vervaardiging van Kaarten. 8vo. *Presented by the Netherlands Government.*

MUSEUM.

Military.

Three Elongated Rifle Bullets. *Presented by Capt. J. Norton.*

A Chinese Bamboo Jacket, worn as defensive armour, taken off the body of a Chinese Soldier at Chingnan-foo, during the Expedition of 1842.
Presented by Major Haley, H.M. Madras Army.

Miscellaneous.

A Gold Medal, presented to Sir William Hillary, Bart. by the Members of the Royal National Institution for the Preservation of Life from Shipwreck. This medal was awarded to Sir William Hillary as the original Projector of that Institution. It is worthy of favourable notice as an early and very beautiful performance of that admirable artist, the late Mr. Wyon. *Presented by Walter Hawkins, Esq.*

Russian Admiralty Flag, found at the foot of the Sheers, in the dockyard, Sevastopol, the morning after the place was taken.

Basket for red hot Shot, taken at the batteries at Kinburn.
Presented by Capt. George St. Vincent King, R.N. C.B.

The Chair was afterwards taken by CAPT. FISHBOURNE, R.N.

TAYLERSON'S DIAGONAL PRINCIPLE OF IRON SHIP BUILDING.

By R. TAYLERSON, Esq.

HAVING been honoured with the charge of bringing before this Institution my patented diagonal principle of building iron ships and of giving such explanation in elucidation of it as I am able to afford, I beg to assure you of my full appreciation of the honour conferred on me, and of my grateful sense of the opportunity thus presented to me of bringing into public life the object of my most anxious and ardent aspirations under the auspices of this distinguished Society.

I fear, therefore, that I shall have to claim a large measure of indulgence at your hands whilst I proceed to lay before you, as clearly as I can, the diagonal principle, the true mechanical basis upon which it rests, and the practical proofs of its superiority over the present vertical mode of building iron ships.

Before we enter on the discussion of the main topic of my address, viz., my diagonal plan of building iron ships, I shall, with your permission, take leave to advert to some preliminary or introductory topics which seem to me to be inseparable from a comprehensive consideration of the subject of iron ship building.

In whatever way we look at this subject we cannot but be forcibly struck with the two great features, or elements, which stand prominently forward in connection with it, and demand our most serious attention: the first is the raw material, and the second is the capital to be brought to bear upon the development of it. That England is favoured beyond all other countries in the enjoyment of the former, is a conceded fact; and, that she commands in an eminent degree the golden sinews necessary to bring the raw material into active vitality, can admit of equally little doubt. Yet, after all, and the history of the world attests the fact, it matters not to what extent we may flatter ourselves as the favoured possessors of those substantial elements of wealth with which our country abounds; without the aid of their handmaid, Science, we can never hope to maintain unrivalled the art of iron ship building, or continue to be the principal recipients of the riches to be derived from this source.

It is true, and we can easily comprehend the fact, that should this country, slumbering in false security in the proud possession of these elements, lapse into a lethargic state of industrial mental culture or scientific training, the raw material and capital might for awhile enable her to hold the vantage ground she proudly occupies; but, should this mental apathy continue, and should a transition take place by which those local advantages would come to something like a level with other countries, in consequence of our capital and raw material finding their way there on easy terms, when superior skill and science were applied to fashion them into floating arks, we should discover our mistake when it was perhaps too late, and we should be painfully reminded of the scathing, sarcastic reply of the

great mathematician Euclid to his pupil Ptolemy-Lagus of Egypt, who, when asked by that indolent prince "if there were no shorter way to learn geometry than by studying his Elements," said, "No, sire, there is no royal road to geometry." Neither is there a royal road to wealth through the unaided instrumentality of those substantial elements, if we will not take the trouble to cultivate the art and science essential to the proper development and shaping of them to the end in view, namely, that of constructing such ships, and such alone, as will give confidence and security to life and property in their perilous ventures on the vasty deep.

Nor is this mere idle theory, for the proof is at hand to sustain it faithfully. From one instance we can learn all. Let us take the fact of America importing our steel from our own Sheffield, and exporting it to us again in the manufactured state in the shape of the adze, the axe, and the spade, at a cost, temper, and finish, cheaper and better than we can produce them. It is plain that this is the result of a superiority on the other side of the Atlantic, in an advanced state of the art of manufacturing the metal. Let us hope that iron ship building will never be an item in this category of national inferiority.

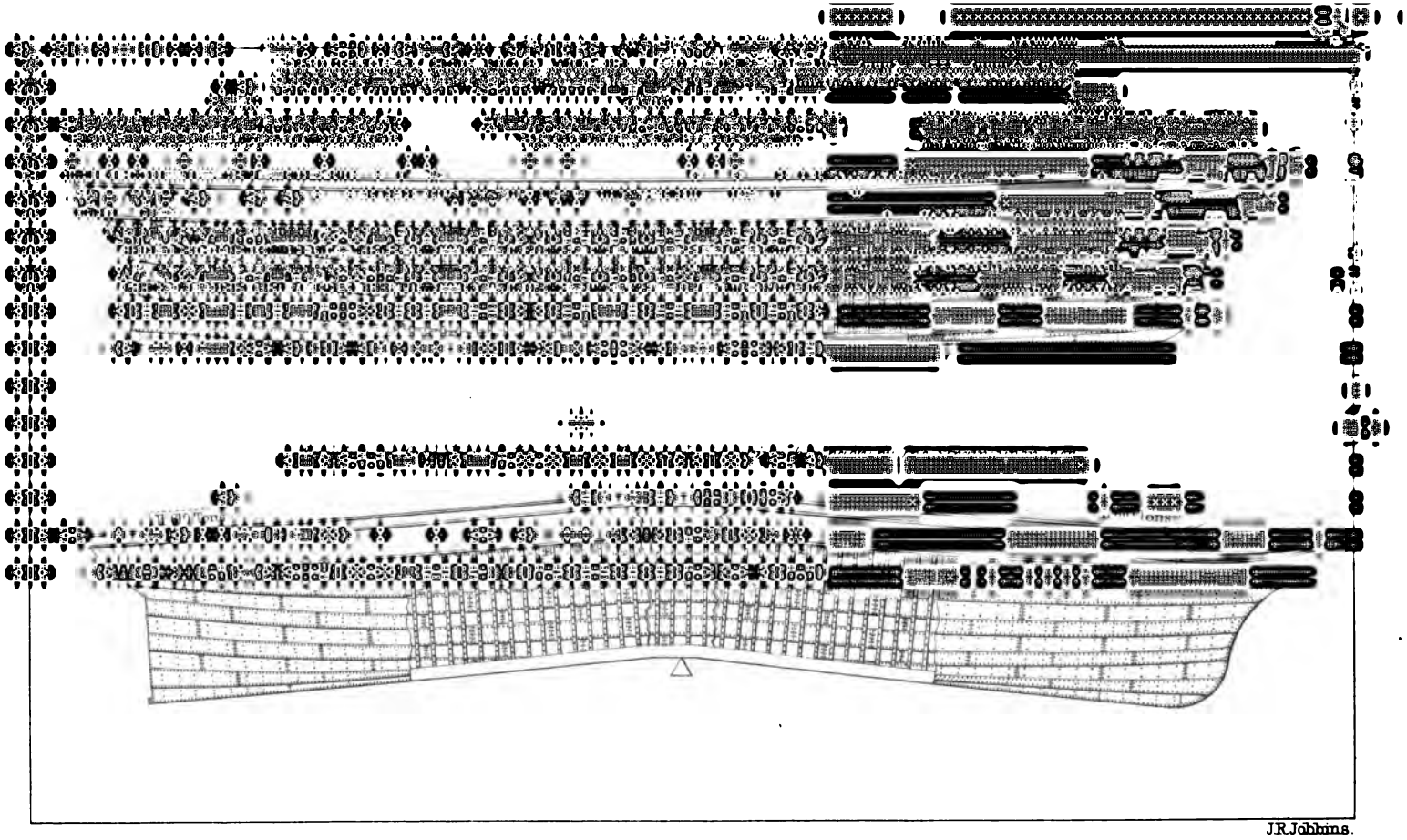
We are now come to the consideration of my diagonal principle of construction as contradistinguished from the present vertical mode of constructing iron ships, which is directly opposed to scientific principles.

On looking at an iron ship of the ordinary construction standing in frame, (Plate I.) it will appear that the frames without the plates offer no resistance to any force tending to tear the ship asunder in the direction of its vertical planes. The frames are placed vertically, and parallel to each other; and, instead of giving strength to the structure, they absolutely require the attachment of the outside plates to keep them in their places. These frames are secured to the outside skin by rivets, in a direct vertical line from the gunwale to the keel on each side of the ship, thus presenting a series of lines of weakness, owing to the displacement of iron to make the rivet holes necessary for attaching the outside plates, just as is familiarly illustrated in the perforations in a sheet of postage stamps.

This weakness, it is manifest, springs from two causes: First, the frames being in a vertical direction and parallel to each other cannot offer sufficient resistance to any force or strain having a tendency to tear the ship asunder transversely. Secondly, the frames being secured, as I have stated, to the outside shell by rivets running in a direct vertical line from the gunwale to the keel, they entail one continuous line of weakness in that direction.

Being thoroughly satisfied that there was a radical defect and an inherent weakness in this mode of construction, and reading of many accidents, resulting in a deplorable loss of life and property, attributable to, and occasioned by, this weakness alone,—the ships, to use the uniform language of these painful narrations, "breaking their backs," or in other words breaking in two parts, from the gunwale to the keel,—I conceived the idea of the diagonal principle, which I shall now proceed to lay before you.

My proposition, in relation to my diagonal method, is this, namely, that, in the case of the vertical principle just now detailed, the line of resistance to any force acting in the direction of the vertical planes of the ship will be in a line with the shortest circumferential line of the body of the ship,


J.R.Jobbins.

thereby opposing the least amount of resistance to fracture coming in the direction of these planes; whereas, in the case of a ship built in accordance with my diagonal principle, the line of resistance to forces acting in the direction of these vertical planes will be diagonal to the circumferential line of the body of the ship, thereby opposing the greatest amount of resistance that can be given at an angle equivalent to the inclination of the frames.

The same argument and the same reasoning apply to the perforations in the plates, or outside skin, which, running in the same vertical line with the frames, as already described, produce a series of lines of inherent weakness in the structure of the ship, and which I propose to remedy by my patented mode of making the line of junction of the butts of the plates diagonal, instead of vertical, as in the present mode of construction.

So much, then, for the superiority of the diagonal principle as applied by me, so far as theory establishes the position, over the vertical method now in use; but I should ill discharge my duty to you, Mr. Chairman and Gentlemen, and to myself, if I came here with a theory of my own, unarmed with that practical proof, which no doubt you will expect from me. I am prepared with proofs, derived from actual experiment, that warrant my asserting that in point of strength ships built on the diagonal system are stronger than those on the vertical, at the rate of 100 per cent.

To this I shall revert more in detail, and give the experiments, when I come to lay before you the structural details of a ship now building by me at Port Glasgow, when I trust you will pardon the emphasis I have used in speaking of the diagonal principle, for I am not without hope that I shall be able to convince you that no iron ship has yet been launched with similar claims to structural strength as the one to which I shall have the pleasure of calling your attention.

The next branch of my patent, to which I would beg to call your attention, is my hollow girder keel and keelson.

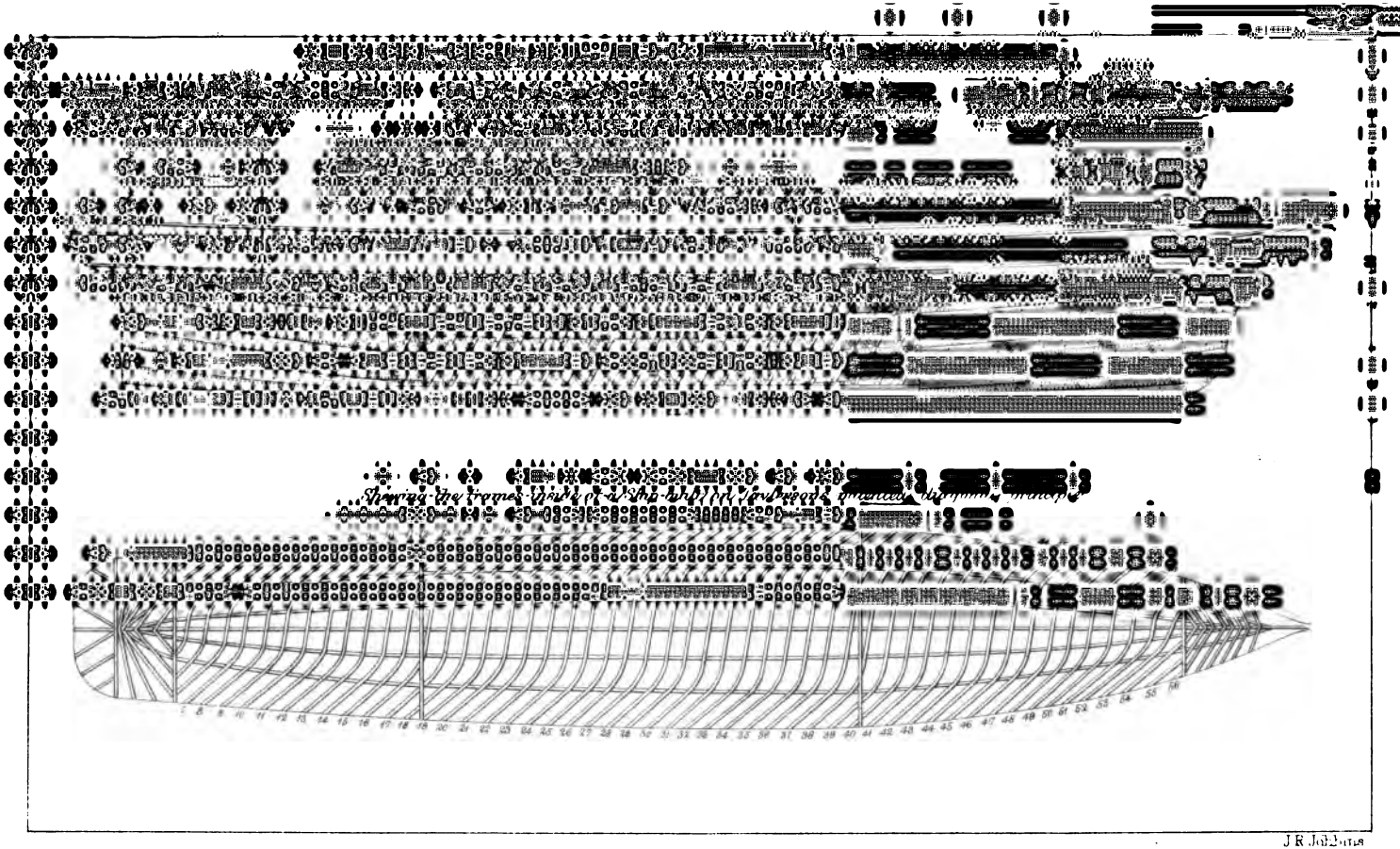
You are no doubt aware that at present iron ships are built upon a solid rectangular bar of iron. Now, it would appear pretty evident that the keel, mechanically speaking, should answer the double purpose of a base on which the frames are to rest, and from which the outside plates spring, and also a foundation of strength to the whole structure; and the question naturally arises for our inquiry, is this solid rectangular bar the best and the strongest that we can supply to meet the requirements of this double purpose? Now, it appears to me that it is not, and that the hollow girder keel and keelson combined will give an increase in point of stability of about 40 per cent. beyond that of the rectangular bar, and this is long since established as an accomplished fact. It is well known that the solid rectangular bar of iron has very little power of bearing a load or resisting a tranverse strain, and that if it were placed on its edge on props at the extreme ends it could hardly sustain its own weight, but that laid flat, and kept in its place by side attachments, as in the hollow girder keel and keelson combined, which I propose in its stead, its strength would be augmented, owing to its increased area, to resist transverse strain not less than from 30 to 40 per cent.; and this is the principle so beautifully exemplified in that magnificent model structure—the tubular bridge which spans the Menai Straits.

I now beg to introduce to your notice another part of my mode of building iron ships, in connection with my diagonal frames, of more than ordinary moment, which, with the public, has done more to establish confidence in the safety of iron ships than any other quality which they possess, I mean watertight bulkheads; but, although bulkheads under the present mode of construction are said to be watertight, they are not so in reality, because were the angle iron frames from which they spring so closely riveted as would be necessary under the pressure of a column of water, say 18 feet (the load immersion of most of our large steamers), the frame to which the bulkhead is secured would be nearly cut in two by the displacement of iron to form the rivet holes, whilst by the mode adopted by me the rivets may be put from 6 to 9 inches apart, and yet make a complete watertight compartment in the ship.

I am now going to give you the structural details of the ship now building by me at my works at Port Glasgow. I shall beg your particular attention to two cardinal points or features of structural stability not to be found in any other ship that has yet been built.

The frames or ribs of this ship, which constitute the main support of the ship, run in an oblique direction from the starboard gunwale down the side and across the keel, to which they are firmly united by an intercostal keelson and four sister keelsons, these continuing their obliquity up the opposite side to the larboard gunwale. The poop and forecastle beams are secured to one frame on the starboard side, and to a different frame on the port side. The main deck beams are also fixed to different frames, and also the lower deck beam; that is, the end of the main deck beam is secured to one frame on the starboard side running forward, and to a perfectly different frame on the port side running aft, which frames, being placed diagonally reverse to each other, are 28 feet apart at the gunwale, but joined together at the keel, by which means almost every beam is fastened to a frame, and the floors are likewise fastened to the frames, so that the ship forms a complete network of iron, embracing diagonal and vertical combinations of structural stability amounting to double that of the present mode of building iron ships. Before this ship can break in two parts or tear her plating asunder, she must break through 20 frames of angle iron $4\frac{1}{2}$ by 3 by $\frac{1}{2}$ inches, as well as 10 frames of angle iron 3 by 3 by $\frac{7}{16}$; whereas in a ship built on the vertical principle the poop and main and lower deck beams are secured to one frame only on the starboard and port sides, and they are three feet apart at least, which leaves every alternate frame unsustained by any beam at all, so that on the application of any force to produce a rupture in a vertical line there is not a single frame interposing to resist the rupture from the keel to the gunwale. The outside plates are $\frac{11}{16}$ and $\frac{3}{4}$-inch thick in all parts when so required by Lloyds'. She is divided vertically by four watertight bulkheads half an inch in thickness, and these are strengthened by diagonal stays or bars; and, having a deck of iron besides one of timber, she is, so to speak, a hollow tubular girder similar to the Britannia Bridge, with this exception, of course, that the bridge is a flat structure, whilst the bottom of this ship is an inverted arch, which is acknowledged to be a necessary form for the bottom of a ship.

Let us now turn our attention to the experiment, made with the most



scrupulous fidelity, to test the strength of this diagonal principle so adopted by me.

Two models were constructed for this purpose, one to represent the present vertical mode of building, and the other to represent my patented diagonal principle. In all other respects the models were precisely similar, each having an elastic keel to admit of a proper distribution of the strain, which in this experiment was obtained by placing weights on the ends, whilst each structure rested on a fulcrum intended to indicate the position of a rock or sand-bank under its keel. The result of this experiment proved that, whilst a ship built according to the ordinary plan would be torn asunder vertically through her plating, or, as the phrase is, "break her back," and break in two, a ship built on my patented diagonal principle would resist a strain from *more than double the amount of force without any injurious effect whatever;* and, in the experiment referred to, the model representation of the principle was not even twisted by the great amount of strain upon it. *(See Mr. Thornton's Report appended, page* 235.)

It is truly appalling to read the long, sad list of casualties at sea. The similarity of narration, and almost identity of language, in which these and many other disasters are recounted, clearly show that they all originated in the same cause—the inherent weakness of which I have spoken, and the want of an adequate power of resistance to any force or strain coming in the direction already indicated; in fact, resulting from the utter radical and inherent weakness in the structure of those vessels.

In glancing for a moment at some of those melancholy accidents recorded in the public journals of the day, I trust I shall not in their relation give offence to the feelings of any gentleman who hears me, for nothing can be further from my thoughts. It is the principle not the man I blame. Ships must be built upon the present system, such as it is, until a better mode is supplied, and it is perfectly plain, from this very similarity of narration and identity of language, that the fault lies not at the door of the shipbuilder, but with the system itself. In narrating the loss of the ship "Eva," The Times says, "that she was struck by a heavy sea, whereby all on board were alarmed by a loud report, which on investigation was found to have been caused by the breaking of the keel right in the centre, the vessel having broken her back." The Times also, in narrating the fate of the "Birkenhead," says, "She went on shore and broke in two halves—400 of the passengers perished." The Liverpool Albion, speaking of the then new screw ship "Yorkshireman," says, "She went on shore and broke in two." The Shipping Gazette, in speaking of the loss of the "Duchess of Sutherland," says, "that on entering the port of Aberdeen she broke in two halves." The "Tayleur" shared the same fate, when 450 souls perished in the wreck;" and in the memorable instance of the "Prince," at Balaklava, The Times states, "that she struck on a sunken rock, filled with water, drifted, grounded, and in less than twenty minutes she broke in two parts, and all on board were immersed in the deep." The loss of the "Transit," in the Southern Ocean, occurred in a similar way, her plating having split in one part, and 600 tons of water having been pumped out of her within twenty-four hours. Many similar cases might be adduced, such as the "Nemesis," the "Ida," the "Loire," the "Pacific," the "City of

Glasgow," the "Ada," the "Brigand," &c. for, unhappily, they abound in the records of our naval disasters.

There never was a period, perhaps, in the annals of naval architecture, when the subject of shipbuilding occupied, and properly, so large a share of public attention; but, whilst we cannot but admire the talent and practical science which have been brought to bear upon the subject, we are amazed to discover a total omission of a cardinal element in the construction of iron ships, and that is, I say it emphatically, *sufficient strength.*

This state of affairs in relation to iron ship building cannot but create some uneasiness in our minds, when we are assured that with the public it is no longer a question which of the two to choose, "the iron or the wooden ship," for to the former they have given a decided preference, on account of lightness, capacity for cargo, speed, durability, and economy in repairing and in cost; this is an array of excellent qualities which must for ever command and maintain, in an eminent degree, a supremacy in the commercial world for the iron over the wooden ship.

In a great country like England, rich in the possession of the raw material, in the capital and skilled labour to bring it into active developement, with a never-failing demand to reward the shipbuilder for his enterprise and skill, he must be dead to every feeling of national pride, and to the most powerful of motives that can sway the human breast, self-interest, if he does not respond, by an untiring zeal and perseverance in the cultivation of art and science. I have already said we must not rely on our local advantages, the mere possession of the raw material, for depend upon it, if in our advance we neglect to further the union of science with industrial art, we must be contented to forfeit with becoming resignation the high prestige we have so proudly maintained, and the uninterrupted prosperity we have hitherto exclusively enjoyed.

A MEMBER.—Did I understand the Lecturer correctly to say that all the ships whose disasters have been described were iron ships?

MR. TAYLERSON.—All of them; and there have been a great many other similar cases—I could name fifty or more.

MR. SMITH (*Editor of the "Artisan"*).—I should like to ask Mr. Taylerson the comparative cost of his system as compared with the very best system of iron construction, either on the Clyde or on the Thames.

MR. TAYLERSON.—There are some who would build for a great deal less than I could; but I should say that, taking any of the first builders, I would undertake to build the same class of ship on the same specification at from 5 to 7½ per cent. extra. There is no doubt that I should use a little more iron. I quite admit that, inasmuch as the frames are longer than in the case of a vertical-built ship, and also that in the plating of the ship the corners have to be taken off the iron. I pay for my iron £1 a ton more—but that is only on the plating.

MR. SMITH.—Do I rightly understand that there is the same carrying capacity for the same displacement?

MR. TAYLERSON.—Yes—for the same displacement.

MR. SMITH.—Because those are material points. If, with an increased

quantity of material, and the same length and breadth, you would have, as a matter of course, greater immersion.

MR. TAYLERSON.—Yes.

MR. SMITH.—And if also, as I take it, your method of construction involves the occupying of a greater internal space, there is no doubt you would have less carrying capacity for the same extreme measurement.

MR. TAYLERSON.—There would be so very small a difference that it would be scarcely worth naming. I would also observe, that, if this system was properly carried out, you might build a stronger ship with a less quantity of iron; for this reason—Lloyd's agents, who have been superintending this ship building, have frequently said, "Take away three of your frames, and yet you would have a stronger ship than one built in the other way." Only last week a gentleman who had been examining my ship for a house in Liverpool told me that if the ship had had two out of every three of her frames less she would have been stronger than a vertical ship. He made that observation himself.

MR. SMITH.—I think Mr. Taylerson has brought before the Meeting an exceedingly ingenious and meritorious system of construction of iron ships. The matter is deserving the best attention of naval architects and those who are interested in the employment of iron ships. I think, however, that the statement of Mr. Taylerson with respect to what he assumes as the defects of the present system of iron construction should not pass without some observation from me. I do not agree with him that, because the ribs of an iron ship of the ordinary construction spring from the keel at right angles thereto, and form a curve of the smallest circumference, that therefore the ship is of a very weak form. I am quite prepared to admit that too little regard is paid to the construction of the keel and of that which should form the vertebræ of the structure; and I also admit that, in a great many instances in the trade of iron ship building, as in every other trade, there is a want of scientific attention to the details of construction; but in all well-designed iron ships, I think Mr. Taylerson will find that what he scientifically sets about doing, and doing in a very nice way, is, or should be, attained from the system adopted of breaking the joints of the plates. I think it is unfair to say that, because the ribs are vertical, at right angles with the keel, therefore the plating is of the weakest possible structure. On the contrary, as the plates in their length have their joints broken, as in the ordinary bonded brickwork, supposing the proper dimension of rivet and rivet hole to have been selected in proportion to the thickness of the plate, the rivet holes should not be the weakest part of the plate. If it were so, I need not say that the Britannia Tubular Bridge would be an exceedingly weak structure. But, as in the case of the Britannia Tubular Bridge and every other hollow girder, whether it be on that large scale or smaller, the strength of the structure depends upon that plating—for, take the plating away, and you have a bundle of square rings, parallellogram shape, which being framed together by longitudinal bars, and plated externally, form the girder; and it is upon the external plating that the strength of the tubular-girder bridge depends. It should be the same in every well-constructed iron ship. I quite admit that from the want of attention, as I before observed, defects do creep into the construction of iron ships, especially

where they are built by contract at very low prices, very often at prices that are unremunerative to the builders; and there lies the great secret of the defect of the most elegantly-shaped ships.

Passing from that subject, I come back to the point of the principle proposed by Mr. Taylerson. He has brought before you an exceedingly interesting subject, though I think he will have more difficulty in carrying out his plan to the high state of perfection which has been attained by the present system of iron ship building than he at present sees. I hope I may be wrong—I wish him every success; but whenever you commence a structure where the lines are constantly varying, and such a structure as an iron ship, where you require well-defined lines, if there is any truth in Mr. Scott Russell's wave-line theory, we ought to be able to determine at every three inches, or every one inch, the exact curves taken at every part of the ship, and to be able to set them out by templates. Mr. Taylerson would have some difficulty in laying down his lines upon the floor, considering that these ingenious and beautiful angle ribs are constantly varying. It becomes an exceedingly difficult thing to lay out a ship with the varieties of curves such as you can obtain by the present system of iron ship building. That is only a matter of opinion; however, it is one which I think, nevertheless, deserves some attention by Mr. Taylerson. Upon the question of weight, to which I alluded in asking Mr. Taylerson the question I did as to the expense, if you place your ribs at the same distance apart, it is pretty clear you would have a greater weight for the same dimensions, and, I think, 5 per cent. is a very small increase of cost for the increased strength which Mr. Taylerson gets by his improvement. I do not exactly understand the arrangement as to the watertight bulk-heads. If it is to give greater resistance to the column of water, which unfortunately is not provided for in all vessels, that part of the vessel being in some vessels which I have seen quite disproportioned to the other parts, and if Mr. Taylerson carries out the improvements he has represented as pertaining to his keel, and which I certainly believe do belong to that system of building, he will have effected a very great desideratum in the construction of iron ships.

CHAIRMAN.—Will you explain how you get over the difficulty alluded to by Mr. Smith as to the moulding?

MR. TAYLERSON.—Iron, when hot, readily takes any form. We had a little trouble at first in laying down this first ship, but as we went on we found very little more trouble than in the common mode. When we first began there was a little difficulty, but afterwards, when we got into play, we got the frames just as well moulded as the common ones. I think you spoke of ships not breaking up?

MR. SMITH.—No; unfortunately that is too true. I think it is more from the defect of the keel itself than from the structure.

CHAIRMAN.—Notwithstanding Mr. Smith's objections, I go entirely with Mr. Taylerson. I think the condition of the present mode of iron ship building is pretty much what that of the wooden ships was before the introduction of Sir Robert Seppings' trusses; and the only difference between iron ships as now constructed and wooden ships before that time is, that in the wooden ships the planks were put edge to edge, there being no means of attaching them to each other except the bolting through

the timbers, while in the iron ship you overlap the plates of iron and rivet through them, which gives great strength in the direction of the ribs. But there is an important point which deserves to be remarked on, which makes it all the more necessary that iron ships should be stronger in the direction of the length, and that is, the want of elasticity in iron. Thus a heavy sea acting upon a ship's quarter lifts her; as a necessary consequence there is a bending action set up, to which the weakest part, generally that near the middle, yields, and the iron, not having elasticity, remains in a bent position; then another and another sea comes, and causes further bending, till it establishes a crack. That was the case with the "Nemesis."

It is also frequently the case that parts of ships are borne down or not supported by an amount of buoyancy equal to the weight in these parts, from which there is a constant stretch upon the centre part of the ship, and a tendency to break. In ships on the old plan, the strain falls between the timbers, therefore no strength in that direction is afforded by them, whereas in Mr. Taylerson's system, the breaking force must cross a series of timbers, say 18 or 20, before the ship can break. That I think is a marked distinction, and an exceedingly valuable one. Another point with respect to iron ships is this, that, although the sleepers upon which the engines are placed run a considerable distance along the ship, affording proportionate strength, and although there have been many plans to obviate the remaining weakness, by girders, making the sleepers in the form of girders, so making an inverted arch on which the engine is placed, still weakness exists beyond the parts reached by them. This Mr. Taylerson's method entirely obviates. Indeed Mr. Smith admits that it is a very ingenious and important principle if the weight is not materially added to. In a man-of-war it is of course a very important thing to give excessive strength to the ship—and in plate-sided ships one of the greatest difficulties is to have a frame-work of sufficient strength to bear the iron plating. By Mr. Taylerson's plan a great deal of strength is added to the water-tight bulk-heads, because the strain is divided over a number of timbers instead of being confined to one or two. When it is estimated that £80,000,000 worth of property is constantly afloat belonging to this country, and which is gradually finding its way into iron vessels, the importance of the subject becomes manifest. I have much pleasure, Mr. Taylerson, in conveying the sense of obligation under which this meeting feels to you, and I trust your invention will obtain that approbation from the public to which it is entitled.

Mr. Thornton's Report.

Having had much practical experience in the manufacture and testing of iron, and the strength of structures built of that material, I have every confidence in stating that the diagonal principle, as developed in the ship now in course of construction by Messrs. Robert Taylerson & Co., at Port Glasgow, exhibits vast superiority in strength over the vertical principle upon which iron ships are usually built.

Suppose a ship to rest upon a fulcrum in the centre of its keel, and equal weights to be placed at each extremity with a tendency to tear the ship asunder vertically amidships, as shown in the accompanying plate, then—

To tear asunder a ship built on the vertical principle, size and weight of metal being the same as Taylerson's, a strain would be required equal to 11,610 tons weight at each end, whereas—

A ship on Taylerson's diagonal principle would bear a strain equal to a weight of 23,152½ tons without any injurious effect upon the vessel. See plates 1 and 2.

These calculations are based on the strength of iron structures as ascertained by experiments in the construction of the Menai Bridge and other works of great magnitude, and the arrangement and distribution of material in ships built upon the vertical and diagonal principles respectively; and they clearly demonstrate that no ship built on the vertical or longitudinal principle can bear anything like the same amount of pressure or strain as that which might be borne without injury by one constructed on Taylerson's patented diagonal principle.

(Signed) ROBERT THORNTON, C. & P.E.

St. Leonard's Iron Works, Edinburgh,
15th November, 1858.

Evening Meeting.

Monday, March 21st, 1859.

Captain E. G. FISHBOURNE, R.N., in the Chair.

The Chairman announced that fourteen Members had joined the Institution since 7th March.

ANNUAL SUBSCRIBERS.

Waller, Geo. H., Capt. 7th Fusileers
Grey, F. D., Major 63rd Regt.
Davis, Sir Jno. F. Bart. K.C.B., Deputy-Lt. Gloucestershire
Hancock, H. J. B., Ens. 45th Regiment
Shipley, W. D., Capt. 58th Regt.
Brown, Henry, Col. H.M. Indian Forces
De Blaquiere, Lord, late Lieut. 41st Regt.
Farquhar, A., Capt. Aberdeenshire Highrs.
Heywood, Wm., Capt. 14th Regt.
Brabazon, L. B., Capt. Roy. Art.
Long, G. P., Capt. 13th Light Infantry
Fletcher, T. H., Lieut. Mil. Train
Bent, Hugh, Capt. Roy. Art.
Spicer, Henry, Capt. late 4th R.S.Midx.Mil.

NAMES of MEMBERS who have paid increased SUBSCRIPTIONS since 7th March.

Stevenson, Wm., Surg. ret. Beng. Army
Watson, D. H., Lieut. R.N.
Reddie, James, Esq.
Young, Wm., Commissary-Gen.
Armstrong, J. W., Lieut.-Col. Prov. Batt.
Wesley, S. R., Maj.-Gen. R. Marine Lt. I.
Hancock, H. J. B., Ens. 45th Regt.
Brown, Henry, Col. H. M. Indian Forces
De Blaquiere, Lord, Lieut. late 41st Regt.
Aitchison, General
Brabazon, L., Capt. Roy. Art.
Dinnen, Jno., Esq., R.N.
Spicer, Henry, Capt. late 4th R.S. Mid. Mil.
Briggs, John, Gen. Madras Army
Leake, M., Major-Gen.
St. George, Jas., Lieut. Col. R.A.
Davis, Sir Jno. F. Bart. K.C.B., Deputy-Lt. Gloucestershire
Burgoyne, Sir Jno., Gen. G.C.B.
Adair, R. A. S., Col. Suffolk Mil. Art.
Shipley, W. D., Capt. 58th Regt.
Cleather, E. I., Col. late R. S. Corps
Wells, J. S., Master R.N.
Baillie, D. J., Capt. R. H. G.
Long, C. P. Capt. 13th Lt. Infantry
Bent, H., Capt. Roy. Art.

DONATIONS.

	£	s.		£	s.
Narrien, Jno., Esq., F.R.S. . .	0	10	Pakington, Sir John S., Bart. .	5	0
Aitchison, Gen.	2	0			

PRESENTS.

LIBRARY.

Books.

Royal Artillery Institution. Occasional papers of. *Presented by the Institution.*

Catalogue of the Admiralty Library. 1 Vol. 8vo. London, 1858. *Presented by Lords Commissioners of the Admiralty.*

45 Volumes of Works, comprising the course of Instruction at the Royal Military Academy, Breda. *Presented by the Netherlands Government.*

A History of British Ferns, by Edwd. Newman.

Principles of Scientific Botany, by Dr. J. M. Schleiden.

Manual of British Coleoptera or Beetles, by J. F. Stephens, F.L.S.

Manual of Botany, by J. H. Balfour, M.D. F.L.S. &c.

Le Bon Jardinier Almanach pour 1846. 2 Vols.

Flore Française, par Messrs. de Lamarck et Decandolle, 5 tomes.

Vocabolario Piemontese-Italiano e Italiano-Piemontese, del Sacerdote Michele Ponza. *Presented by Capt. H. L. de la Chaumette.*

The Campaign in India, 1857-58, from drawings made during the eventful period of the Mutiny, by George Francklin Atkinson, Capt. Bengal Engrs., illustrating the Military Operations before Delhi and its neighbourhood, with descriptive letterpress. Folio, London. Jan. 1st, 1859. *Presented by Colonel T. Taylor.*

Royal Geographical Society. Proceedings of. Vol. III. No. 2.

Maps—Plans.

Map of the Gwalior District, in 4 sheets. *Presented by Secretary of State for War.*

MUSEUM.

Military.

Two Liquid-fire Rifle-shells, adapted to a deep-grooved Enfield Rifle.
Presented by Capt. J. Norton.

"TENTS," from their EARLIEST PERIOD to the PRESENT TIME; showing the NECESSITY for providing WATERPROOF and WELL-VENTILATED TENTS for the covering of Troops in the Field; and the evil results when inefficient shelter is provided: considered in a sanitary and pecuniary point of view.

By GODFREY RHODES (MAJOR UNATTACHED).

THE subject of "tent-architecture" is one of very early origin; and, although the necessity of supplying efficient shelter for troops in the field is at the present time fully acknowledged, yet little or nothing has been done towards accomplishing that requirement.

It is a fact that enormous sums of money and great encouragement are awarded for the perfection of destructive missiles; yet little or no support, and but scanty supplies are granted, towards (what ought to be the first step) supplying efficient shelter for the preservation of the health of our own troops when encamped in the field.

The earliest mention we have of tents is in the 4th chapter of Genesis and the 20th verse, where we are told that "Jabal was the father of such as dwell in tents and of such as have cattle;"* evidently meaning that he was the inventor of tents, and of pitching those moveable habitations required for a nomadic life.

We find after the Flood, that Noah,† Lot,‡ Abraham, and the two sons of Isaac (Esau and Jacob §), lived in tents; and, although it is natural to suppose that, as "Esau was a cunning hunter and a man of the field," he required those portable dwellings, yet we find (Genesis, chap. 25) that "Jacob was a plain man dwelling in tents," giving us sufficient evidence that tents were the earliest constructed habitations of man.

It is impossible to ascertain with precision what was the peculiar form and construction of the Patriarchal tents; but, as the Arabs deviate so little from the customs of their forefathers, we shall not be far from the truth if we consider the present Arab tent the nearest existing approximation to the ancient model.

To illustrate the subject I will briefly describe the present Arab family tent.

Their most usual sized tent is from 25 to 30 feet long, by about 10 to 12 feet in breadth; it has nine poles. To pitch the tent, the three

* About 4000 years B.C.
† About 3156 years B.C.
‡ B.C. 2080.
§ B.C. 1915 years.

longest poles (viz., from 7 to 10 feet in length) are placed in the middle, at equal distances apart, and three of the others (about 5 or 6 feet long) are placed in like manner on each side; to the top of these, the black goat's-hair cloth (with which the Arabs cover their tents,) is secured; and owing to the skill of the women, who manufacture all the tent coverings, even the heaviest rains do not penetrate this closely woven fabric. The side coverings, or walls, are often of a coarse woollen cloth. The tent-coverings are kept stretched out in the usual manner, viz., by cords, which latter are fastened at one end to the top of the poles, and at the other, to pegs driven into the ground, at the distance of three or four paces from the tent.

The front of the tent is usually kept open, except during the winter, and the back and side hangings are so managed, that the air can be admitted in any direction, or excluded at pleasure.

The weight of a tent of the above dimensions is about 1500 lbs., or the load of two strong camels.* I may mention that tents of much larger, and even smaller, dimensions are used, according to the rank and wealth of the owner.

It is not my intention to enter here into the minute details of the tents and coverings as used by the Israelites during their wanderings in the Wilderness, as such would take up too much time, and perhaps afford but little interest to many of my hearers; but, as there is a diversity of opinion with reference to the various translations of the Hebrew words "Or thakhash," which have been generally rendered badger-skin, (such being supposed to have been used as the outer covering of "The Tabernacle,") I may mention that there is no certainty that the outer covering of "the Tabernacle" must necessarily have been made of badger-skins: on the contrary, the commentators, as Jarchi, &c., raise the question, whether any part of an unclean beast (and such is a badger) should or could have been used for the outer covering of that Sacred building.

The celebrated and generally correct historian Josephus, in his description of the offerings made by the Israelites when encamped at the foot of Mount Sinai, only states "that the upper curtain was of a stuff that was proof against rain;" again, "that the outer covering was of skins, for a shelter against heats and rains, and for a fence against the injuries of the seasons." Niebuhr says, that there is a fish in the Red Sea which the English call porpoise or sea-hog, and which is called by the Arabian merchants "dāhash:" the skin is used for bucklers, and is said to be musket-proof. Other authors say the skins are used for covering huts, &c. It is well known that badgers do not now inhabit (if they ever did) the neighbourhood of Mount Sinai; and, as the porpoise is still to be found in the Red Sea under the name of dāhash, it may fairly be assumed that the "thakhash" of the Hebrew is the "dāhash" or porpoise of the present day. The circumstance of the want of water in the wilderness, and the close approximation of the Red Sea to the Sacred Mount, may be of sufficient circumstantial evidence, that the Holy Tabernacle was covered on the outside with the skin of the porpoise, and not with that of the badger. There is nothing very remarkable in the employment of fish-skins as an

* Camels can carry from about 400 to 700 lbs., and elephants, from 1000 to 1500 lbs. each.

The Circular Single-poled Camp Tent.

This tent, with some slight modifications, has been in general use in the British army for about 60 years (if not rather longer). Formerly, the canvas was supported by one centre pole, and without the short vertical wall with which the present conical tents are supplied; its height was 9 feet, its width about 12 feet, and it was capable of holding 12 men.

A complete tent so constructed only weighed 43 lbs.

The following are the dimensions, &c., of the "circular conical single-poled tent" at present in use. (I may premise, by stating, that the British army tents vary in size, and consequently in weight.)

The diameter of this tent is 12 feet 6 inches; height, (or length of pole,) 10 feet 4 inches; accommodation for 12 to 14 men; weight of the linen tent (complete) when dry, is from 68 to 75 lbs., and when wet, about 104 lbs. The height of the vertical circular wall is 12 inches, and its object is to give increased head-room to the soldiers when lying down.

The number of pins required for this tent is 43, viz. 40 for the tension ropes and loops, and 3 for the long storm ropes. This tent is provided with one triangular entrance, and is deficient* of a proper means of ventilation. The above sized tent contains about 512* cubic feet of capacity, allowing to each soldier about 64 cubic feet, 8 men per tent; about 51 cubic feet, 10 men per tent; about 42 cubic feet, 12 men per tent; and about 34 cubic feet, 15 men per tent.

General Defects of the British Army Tents.

Their general defects consist—

1st.—The canvas of which they are made is not always of the best material.

2nd.—The canvas and tent-ropes are not waterproofed; and, owing to their absorption of moisture, the weight of the tent is increased nearly one-third, and by their contraction, when wet, materially assist in pulling the wooden pegs out of the ground, thereby rendering the tent less secure during stormy weather. The alternate saturation, and drying of the canvas and ropes, must materially tend to rot them.

3rd.—Want of an improved method in the construction of the present army tents, from the apparent inability of applying to them an efficacious and simple plan of thorough ventilation, &c., which, from the latter being very defective, together with over-crowding men into a confined space, is, but too often, the chief cause of those zymotic diseases—viz. "fevers," "diarrhœa," "dysentery," and "cholera," which are the greatest enemies to troops employed in active warfare.*

Young lads of 18 to 20 years of age, are much more liable to contract zymotic diseases, than men of 22 years and upwards; the former are generally deficient in physical strength, whereas the stamina of the latter, being more fully developed, their constitutions are better able to bear the harassing fatigues incidental to armies in the field.

* *Vide* Report of Sanitary Commission, 1855—56.

To illustrate the point in question, I may, perhaps, be permitted to briefly mention "that during the campaign of 1809, some troops which were cantoned in the north of Germany marched to Vienna, and, although the distance was only short, all the hospitals on the line of march were filled with sick: more than one-half of these men were under 20 years of age."—Again, "during the year 1805, a French army, which was cantoned in the neighbourhood of Boulogne, marched about 400 leagues to join the grand army in Moravia, prior to the battle of Austerlitz (fought 2nd December); but owing to the more matured physical strength of these men, (all above 22 years of age and 2 years' service,) this long march was accomplished without leaving almost any sick in the hospitals on the line of route."

With respect to No. 1 Defect, I find that the two Commissioners (Sir John McNeill and Colonel Tulloch) reported, in 1855–56, that "some of the tents were of an inferior quality, and that in many instances the army was obliged to use the single-poled camp-tent for hospitals, instead of the marquee, although the latter was far more appropriate for such a purpose."

No. 2 Defect.—I have already called your attention to the increased weight of the army tents when wet; and, with respect to their general deficient waterproof qualities, I can state, from personal experience, that in the autumn of 1848, I was encamped for about two months, with a detachment of my regiment (then 2nd Batt. 60th Rifles), at Kilkenny; and, although the weather was not unusually wet for Ireland, still a misty dew penetrated the canvas, and rendered everything within the tent uncomfortably damp.—During the winter of 1854, when I was in the Crimea, the general complaint of the British army tents was, that they were neither waterproof nor ventilated, and I can well remember the wet and puddled state of the windward half-ground portion of the interior of many of the tents, caused from the incessant beating of the rain and wind against the canvas, which latter was ill adapted to resist the combined action of the rain and wind, for a continuous period of sometimes ten days: on the contrary, the "Turkish Circular Conical Tent" was dry, warm, and waterproof, owing to its covering being of double cotton canvas; besides, from its great width, and comparative lowness, it withstood the fearful hurricane of the 14th of November, when nearly all the British and French tents were blown down. With reference to the deterioration of the tents from the effects of the variation in the weather, I find, on reference to page 123 of the printed "Report of the Sanitary Commission," (despatched to the seat of war in the East, in 1855–56,) that in the month of May, 1855, the Commissioners "recommended the striking and removal of some tents to a fresh surface, owing to the damp state of the ground inside the tents." The Commissioners were informed, that "the supply of tents was deficient, and that it was impossible to strike the tents pointed out, as they were too much decayed to admit of removal."

No. 3. Defect.—With respect to the very important subject of defective ventilation, &c. of the present army tents, I beg to bring to your notice the recorded opinions of several professional men.

The late Dr. Robert Jackson, "Inspector-General of Army Hospitals," states, that "There is great room for improvement in the manner ordina-

rily employed for covering troops from the inclemency of the weather during a campaign." He recommends the use of "a carpet of painted canvas to be laid on the ground inside the tent, and, by preventing the ascent of moisture, generated by the raised temperature within the tent, from its occupation (more particularly by the immediate or near contact of the heated bodies of the men with the surface of the earth), would greatly tend to lessen those evils (arising from the contaminations of the air) to which soldiers are subject, when crowded together in close or unventilated tents."

The doctor recommends "a tent with a light roof," but acknowledges "that the application of it is connected with trouble." He further states, that "a roof, similar to that of a marquee, is liable to be overturned by strong winds, and a tent with close walls is liable to be contaminated."

I must again refer to that valuable "Report of the Sanitary Commission" in respect to the general want of ventilation of our army tents. They state "That the most obvious sanitary defect in the tents was their want of ventilation." "It is usual on a march for 12 to 15 men to sleep under a bell tent. The cubic space for each soldier is 51 to 64 cubic feet, but the consequent evils from overcrowding tents would be greatly mitigated by ventilation. The indispensable necessity of renewing the interior atmosphere of the tent is indeed fully recognised, for there are a few small openings for this purpose, near the apex of the tent, but they are of too small a size to be of use."

"*Ventilation.*"

Again, "We had occasion to examine the ventilation during the outbreak of cholera in May 1855, and were struck on entering the tents by the foulness of the atmosphere. This led to inquiry, and we found the men were perfectly aware of this defect, and complained of it themselves, especially in the mornings."

"At the same date we found instances of sick, being treated under bell-tents,* and in going into one of these, we saw pans of peat charcoal on the floor, and were told by the surgeon, that were it not for the use of charcoal for absorbing the emanations from the sick, the air of the tent would have been unbearable—a very sufficient proof of the great necessity for a better ventilation."

The Commissioners again state, "that to remove as far as practicable the evils of overcrowding tents, it appears indispensably necessary to improve their ventilation." With respect to the sanitary condition of the "Hospital-Marquees," the Commissioners state that "the usual method of ventilation in 'marquees,' is by opening or raising the side walls; but this method can hardly be said to be sufficient, even in favourable weather, and still less is it, when from rain or high wind the sides cannot be opened. Even in the fine weather, it was remarked that the air under the roof of the marquee was hot and stagnant (although the sides were open), because there was no provision for its escape above."

The Commissioners state that "*the whole question of ventilation, as regards field hospitals, is one of very great importance;*" and with respect

* It is to be remarked, that the "bell-tents" here referred to are the "single-poled conical soldiers' tents."

to the rapid recovery of the sick and wounded, they state, that "well-ventilated field hospitals answer much better than would be fulfilled by a much larger amount of ill-ventilated cubic space." Consequently, "to well ventilate a field hospital is, in other words, to save transport." They pointedly remark, that "a permanent and independent means of ventilation is particularly required at night, when the doors and side hangings are closed."

In their concluding remarks they state, "that the atmospheric impurities arising from over-crowding and defective ventilation of tents, and huts, were a frequent predisposing cause of zymotic disease." And that, "as the neglect of the sanitary condition of camps, tents, barracks, and hospitals has hitherto, in all countries, climates, and seasons, been the cause of the largest amount of loss in armies, the whole subject (closely connected as it is with the physical efficiency of Her Majesty's forces) demands in future a *practical development* commensurate with its importance to the public service."

During the last three years and five months of the Peninsular war, at the period when the greatest activity prevailed, the mean strength of the British Army amounted to 61,511 men, and the sick to 13,815, being 22½ per cent. The mean ratio of inefficiency from wounds did not exceed 1½ per cent.

The average strength of the British Army in the Crimea during the ten weeks intervening between the 5th May and 14th July, 1855, was 38,507 men. The total admissions into hospital were 22,541, or 58 per cent. of the force; the per-centage of deaths from wounds (exclusive of deaths in the field) was 20 per cent.; whereas 74½ per cent. admitted into hospital, and 96 per cent. of the total mortality from disease, originated from zymotic cases, such as fevers, &c.

Major Rhodes' Tents.

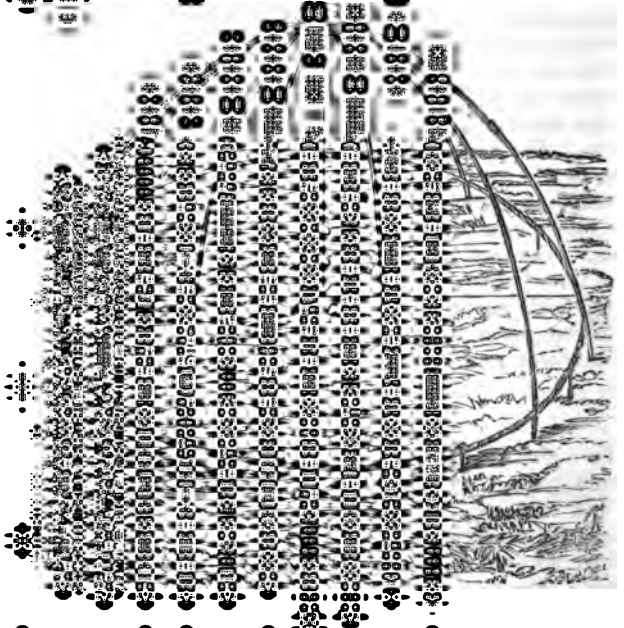
With the view of supplying a remedy for the several defects of the present army tents, I will now briefly describe some tents of my own invention, not that they being my own merit a greater attention, but that I believe the proposed improvements will materially add both to the health and comfort (in all countries and seasons,) of dwellers in tents, and I further hope, may render "Tents and Tent-Life" more acceptable.

From the diagrams you will perceive that I have applied my system to three forms of tents, in all of which the same principle of construction is embodied.

No. 1 represents the skeleton or uncovered frame of my field-tent, from which you may easily comprehend the simplicity and strength of its construction.

The frame is composed of stout ribs of ash, bamboo, or any other flexible material. When required to pitch the tent, the prepared double-twisted ground rope or band is hooked together, and laid to the full extent of its own circle on the ground; the butt-ends of the flexible ribs are then inserted within the loops or openings already made in the circular rope, and, when the latter has been stretched out to the form required, the butt-end of each rib is forced into the ground (see Diagram No. 2, p. 247); and to facilitate this operation, the extremity of the rib is provided with a metal

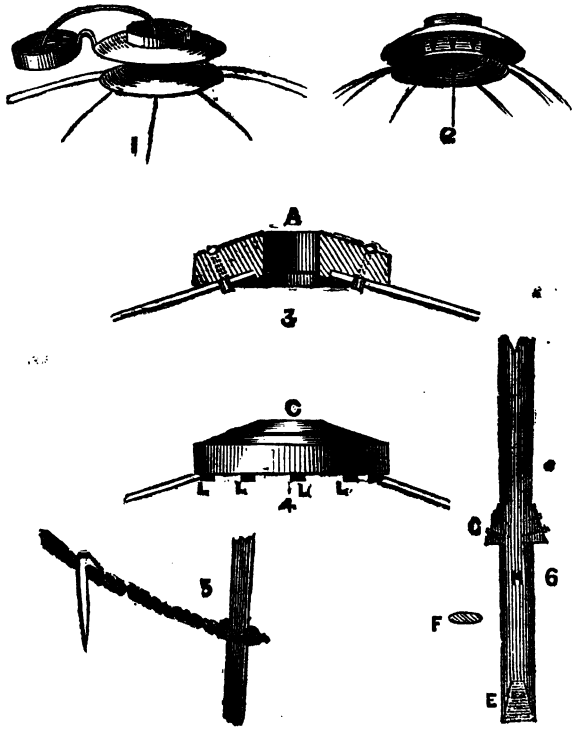
provided with stops, so
und the butt, cannot slip
ound beyond those stops.
is driven over it at the
he ribs (if detached from
e secured to the top ends
wards, and then inserted
hem. The latter has a
p ventilation to the tent.
er the frame, and when
e inner one, the bottom
ound-band by means of
its base.



e ; but, to add increased
sly attached to the canvas,
further add to the firmness
in which the whole tent
secured to the inside of the
prepared for that purpose.
und, are placed the butt-
les usually required by a
id on the canvas ground-
s base, not only greater
benefits the men in a
nd currents of air which

enter at the bottom of the tent do not by the above means blow direct on the bodies of the men, thereby obviating the necessity of providing straw to place round the bottom of the tent, which at present is absolutely necessary to prevent the men from getting stiff necks; by this simple arrangement the purchase of straw usually supplied for tents is obviated; and what must be clearly perceived, is, that fewer men are liable to catch cold, consequently the hospitals would be much less incumbered, and the army rendered much more efficient. It is the prevention, and not the cure of such trivial complaints, that should be most attended to. When it is

[*See p.* 250.



No. 2.—SECTIONAL (ETC.) DETAILS OF MAJOR RHODES' TENTS.

No. 1. Represents outside of the ventilating hat of "Guard," "Field," and "Hospital Tents (top part open)."

„ 2. Inside of ditto, and cord for closing the top part of the ventilating hat.

A 3. Section of the wooden head-piece.

C 4. Side elevation of ditto, showing the iron sockets (L) which receive the top ends of the ribs.

5. Portion of ground-rope, with the butt-end of the tent-rib passed through the rope; also a tent-peg to secure the ground-rope, between each of the ribs.

6. E. section of butt-end of tent-rib, 14 ft. 2 in. long, 2 by ¾ in. at butt, 2 by ½ in at the top. G. cast iron stops, secured with iron screws. H. tent-rib, of ash or other flexible wood or suitable material.

No. 3—MAJOR RHODES' FIELD-TENT.

No. 4—MAJOR RHODES' HOSPITAL-TENT.

necessary to light a small fire within the tent, the exterior ventilating hat or cover can be opened, so that an easy and free egress for the smoke is obtained.*

With respect to the saving of space, when ground is an object, I can pitch five of my hospital-tents on the same number of square yards of ground, as is required to pitch (including room for the tent-ropes) one Government hospital-marquee—thus, one of the latter requires about 340 square yards of ground (or 20 paces by 19), whilst five of the former only require about 315 square yards of ground. The space necessary for one of my hospital-tents is about 63 square yards, or about 7 paces by 9.

This is a decided advantage when but a small space can be procured for the encampment of troops. My field-tents can, if required, be pitched within a few inches of each other, thereby also occupying much less space than the "circular conical Government tents."

The cube quantity of air contained in my tents is as follows:—

"*Hospital-tent*," 30 feet long, 15 feet wide, and 10 feet high, is equal to 2383½ cubic feet; or about 119 cubic feet for each soldier, having 20 men in the tent; or for 30 men, about 79½ cubic feet each.†

"*Field-tent*," 13 feet diameter and 8 feet high, is equal to 531 cubic feet; or, for 8 men in a tent, about 66½ cubic feet each; and for 12 men, about 44½ cubic feet each.

"*Guard-tent*," 9 feet diameter, and 5 feet in height, contains about 159 cubic feet.

An ordinary "single-poled circular conical tent," without any side walls, but occupying the same space of ground, and of the same height and width as my field tent, contains about 354 cubic feet of air, thus allowing about 44½ cubic feet for each man, 8 men in the tent; and about 29½ cubic feet for each man, 12 men in the tent.

I beg to state that all my tents are perfectly ventilated, and that the government tents are deficient in that most important particular.

The number of cubic feet of air allowed to each soldier in many of the barracks in England is only 300 feet, whereas for prisons the rule is 1,000 cubic feet per individual.

The colour of the canvas of my tents is grey, and that of the Government tents is generally white, or a very light colour. The glare from white canvas is not only very objectionable for the eyes, but is also easily seen from a great distance, thereby often disclosing to the enemy those strategical movements of which, if the colour of our tents were of a dark-grey, he would be ignorant.

In conclusion, I beg to read a few extracts from Official Reports on the "Suitability, &c., of my Tents," as applicable for military purposes, based on Reports of their actual occupation by troops in the field, which his Majesty the King of Hanover has been pleased to grant me.

* Weight of "Field Tent" (13 feet in diameter), when complete, 95 to 100lbs.

† Weight of Army Hospital Tent . . 507 lbs.
„ Rhodes' Hospital „ . . 395 „
In favour of Major Rhodes' Tent . . 112 lbs.

EXTRACTS FROM "THE HANOVERIAN GOVERNMENT REPORTS."

COLONEL RICHERS' REPORT.

(Translation.)

To Major and Adjutant-General von Tschnirschnitz, Hanover.

CELLE, *Oct. 12th*, 1858.

IN fulfilment of an official request of the 12th ultimo from your Excellency, to his Excellency Leiutenant-General von Dachenhausen, commanding the 1st corps division of the 10th Federate army corps, there were brought me in the camp at Wülfingen, three tents of a new invention of the British Captain Rhodes, with the gracious commands of His Majesty the King, to pitch them in the camp of the Second Regiment of Infantry; to examine them, as to their suitability and durability, and to furnish your Excellency, on return to garrison, with a Report of the information obtained.

Captain Rhodes calls these tents—

"HOSPITAL TENT," called *Tente d'Ambulance* in the French printed paper I received.
"FIELD TENT," *Tente de Campement* in the French print; and
"GUARD TENT," *Tente de Poste ou d'Abri* in the French print.

These three tents differ essentially in their construction from our linen encampment tents, in that the principal support does not consist in the tent pole, but in ribs, the upper part of which is flexible; thus forming a vaulted frame, over which the covering is placed. From this arched shape, the interior space of the tent is much increased from top to bottom; the men can stand upright without difficulty (this is not the case, however, with the very low watch tent), and the middle area of the tents is not diminished by the pole. There is a very useful arrangement within these tents for placing the muskets and accoutrements of the men, which, while but slightly decreasing the interior space of the tent, affords much convenience to the soldier.

This arm-rack sling is composed of two short ropes (each about six inches in length), having a loop-sling and wooden toggle or pin, at alternate ends:—these ropes are fixed to the canvas sides of the tent at about three feet off the ground, but, at the juncture of that part of the canvas which touches the ribs, so that by placing the butt ends of two muskets on the inside ground curtain, at, or close against the butt end of the rib (which has been forced into the ground), and by circulating round the top end of the barrels the two short ropes, and then fastening the latter, the muskets are securely and handily placed upright against the sides of the tent. The accoutrements can be hung over the ropes, between the canvas of the tent and the barrels of the muskets, which, by the projection of the latter beyond the ropes, the accoutrements cannot slip off. Thus, for every two soldiers lodging within the tent, there is one sling, and on account of only two muskets being placed in each loop, the soldiers can readily lay hold of their own arms and accoutrements, even in the dark, without the slightest confusion or delay.

The covering of the tents is of double white cotton canvas, sewed together. During the weather we had at the camp at Wülfingen, the tents were much warmer in the cool of the night than our linen ones, and much cooler than the latter, in the heat of the day. In this respect Captain Rhodes's tents have a twofold advantage over the linen tents of the Government. The pitching and striking of these tents offer no difficulties. The non-commissioned officers and privates under my orders learned the way after once seeing a tent pitched by the armourers (*zeughaus-officianten*) sent me for that purpose.

Eight men, after very moderate practice, can pitch an hospital tent in from ten to twelve minutes; and four men a field tent in five minutes; the same with a guard tent.

After these general observations, I will proceed to give more special details of each tent.

I.—THE HOSPITAL TENT.

This tent is highly to be recommended for camps. It is 30 feet long, 15 wide, and 10 high, and can conveniently accommodate twenty patients. It has the form of a long oval; and when ten patients lie down on each side of the tent, there is sufficient space left in the middle for a small passage, so that the doctor can reach every patient with ease. As soon as the tent was pitched in the camp at Wülfingen, and furnished with straw, I had it occupied by the camp patients of the regiment, hitherto lodged in straw huts. They all expressed themselves (in reply to my inquiries) much pleased with the change; the head surgeon [Dr. Neuber] also frequently informed me, that the tent was excellent, and by far surpassed the straw huts. There are also slings fastened to the walls of this tent (such as I have previously mentioned) for the purpose of supporting the arms, so that the patient can take all his things with him into the tent without being incommoded.

This "Hospital Tent" (as before observed) differs considerably in shape and size from the field tent. It has a larger exterior expanse and head-room, which not only permits of the soldiers standing upright, but supplies a much purer and larger circulation of air. There is another canvas covering, of blue and white striped cotton stuff, which is stretched over the whole of the interior arch of the tent, so that this tent is provided with a threefold covering; the ingress of heat or cold, is, by this means, very much moderated. There are, moreover, in the upper part of the arch, several ventilating holes, which can be opened and closed at pleasure. By this means, the atmosphere of the tent can be kept perfectly pure, and without inconvenience to the patients; and, as these ventilators are only made through the double canvas covering, and not through the under one, the exterior air, on entering within, and near the apex of the tent, is checked by the third, or inside covering, thus only reaching the interior of the tent with a gentle current. In short, this tent answers every purpose that can be desired for an invalid tent.

II.—THE FIELD TENT.

This tent (or the soldier's camp tent) has also the advantages of its arched shape being better adapted for enabling the soldiers to stand upright than is the case with our present linen tents; that the tent-ribs do not limit the interior space; that the arms, without occupying room, can be strapped or secured to the tent-wall, and that the canvas covering does not allow heat and cold to enter so easily as in our linen tents. Besides the above important points, the tent has another good arrangement, viz., that at the top of the dome there is a ventilating hole, so that when the tent is closed all round at its base, as during the night-time, still there is a continuous current of fresh air, entering at the top of the tent; and in warm weather, when the tent doors are both opened, a cool current of air is obtained: this aperture is protected against the entrance of wet by a leathern hat. I may mention as a further utility, that the ground curtain (with which all the three tents are provided), is a sort of canvas carpet, which is buttoned to the lower part of the canvas inside of the tent, covering about two feet of the ground. This ground curtain is used to place the men's things on, such as their knapsacks, arms, &c., and affords also this advantage, that, by the weight placed on it, it materially assists in maintaining the stability of the tent in stormy weather.

The men whom I placed in this tent scarcely ever required their woollen blankets during the night, while those in the linen tents could not do without them—a proof how very much warmer it was in the former. The men gave a decided preference to this tent over the linen one of the Government.

III.—THE GUARD TENT.

This tent seems intended for active war purposes or outposts only. With the object, probably, of its better escaping the observation of the enemy, it is of grey colour, and so low and small (five feet high by nine feet in diameter), that only about six men can conveniently sit in it. In my opinion, its only use can be to afford alternate shelter in bad weather to men on outpost duty.

(Signed) RICHERS,
Colonel, and in command of the Regiment.

DR. NEUBER'S REPORT.

CELLE, *March 8th*, 1859.

MAJOR RHODES' "Hospital Tent" (tente d'ambulance) is 30 feet long, 15 wide, and 10 high, and is of an oval form, and of a vaulted construction. Instead of a tent-pole, wooden bowed ribs serve as a support to the tent. The covering of the tent is composed of double white cotton canvas sewed together. Underneath this canvas covering, there is another composed of blue and white striped cotton, which is stretched over the entire arch of the tent, and is capable of being lowered or raised, according to circumstances. In the upper part of the exterior tent-covering there are two ventilating holes, made to open and shut, which, by reason of the air that permeates through them, keeps the atmosphere between the outer and inside coverings always fresh and pure.

The tent was pitched in the camp of the right wing of the regiment, on a somewhat rising ground, and remained ten days under my superintendence.

The weather was always favourable, although it was hot and dusty during the day, while at night it was often very cool.

The greatest number of patients occupying the tent, at any one time, was 18, of which several had previously been treated in the straw huts.

When hospital accommodation is required for troops in the field (either with reference to the employment of tents or huts), the three following very important points are to be considered:—

"I.—Sufficient light."

"II.—Sufficient accommodation, with as much comfort as possible for the sick, and for the unrestricted movements of the surgeon."

"III.—Purity of the air, and the greatest possible protection against the influence of temperature and weather."

As the above points form the ground of the following report on "Rhodes' Hospital Tent," I take occasion, at the same time, to notice the advantages and disadvantages of the straw hut in these particulars, with the view of corroborating still more my previously delivered opinion, viz. that the former deserves the preference.

I.—SUFFICIENT LIGHT.

The canvas coverings of "Rhodes' Hospital Tent" permit of a thorough, sufficient, and uniform light penetrating through them during the day-time, so that the surgeon has the advantage of being able to make his examinations, and effect every necessary arrangement in any part of the tent in which his patients may be lying, and in whatever position they may be placed.

The strong rays of the sun penetrate the outer and inside coverings of the tent in such a modified form as to neither distress the eyes of the patients, nor incommode the medical officer; on the contrary, in the straw hut, the light fell partially and insufficiently through the window; and, at the examination of the patients, the door was generally obliged to be opened, so that they might be brought near to it. When the door was thus thrown open, it was hardly possible for the surgeon to avoid standing in his own light, which, for example, in dental operations, is an evident disadvantage. In stormy and wet weather, the defective light in the straw hut was of still more serious consequence.

II.—SUFFICIENT ACCOMMODATION, WITH AS MUCH COMFORT AS POSSIBLE FOR THE INVALIDS, AND THE FREE MOVEMENT OF THE MEDICAL OFFICER.

"Rhodes' Hospital Tent" can in case of necessity accommodate twenty invalids (viz., ten on each side), with a space of three feet by six feet six inches for each man. As the invalids lie with their heads near the walls of the tent, and their feet inwards, sufficient space is left in the centre of the tent for a passage through its entire length, from which the surgeon can easily inspect every patient; on the other hand, the invalid can make his way in and out of the tent without disturbing his neighbour. With patients to the number of eighteen, I could reach every man without any inconvenience, and there was still sufficient room for each invalid to have a drinking vessel, &c., placed near him. It is therefore evident that, from the above ample space and arrangements, "Rhodes' Hospital Tent" *affords the best shelter hitherto obtained in camp hospitals.*

A great advantage is also afforded from the height and vaulted form of the tent, as both the surgeon and patient can move about without stooping; moreover, the patient does not lie under a slanting and narrowing roof (running up to a point over his face), as in the straw hut, and in the ordinary camp tent.

Besides this, each tent-rib (on which the accoutrements of the soldier are hung, without any inconvenience to him) serves as a fixed point for the bed-place of each patient, by which a regular and orderly arrangement for their lying down is easily secured.

These proportions of space (as above-mentioned) belonging to this Hospital Tent, stand out *so prominently*, when compared with those of the straw hut, that no further explanations can be required in this particular.

III.—PURITY OF THE ATMOSPHERE, AND GREATEST POSSIBLE PROTECTION AGAINST THE INFLUENCES OF TEMPERATURE AND WEATHER.

The air in "Rhodes' Hospital Tent" was always pure and wholesome, even in the morning, after the entrances had been closed the night before; it was equally so in the daytime, when the rays of the hot sun fell strongly on the tent.

The construction of this tent, with its system of ventilation, not only permits of a gentle circulation of air within, but also materially contributes in maintaining that air in a pure and wholesome state: on the contrary, in the straw hut, the atmosphere was never so pure and wholesome, and this was more particularly felt in the morning, after the door and window had been closed during the previous night. In connection with this subject, I may observe, that in the straw huts at the camp of Nordstemmen, millions of little flies made their appearance, soiling everything they touched; but in "Rhodes' Hospital Tent," as well as in the other two tents, no trace of them was visible. The temperature in his tent during the heat of the day was higher than in the straw hut, but at the same time was not disagreeable, and never obtained such a degree of heat as in the ordinary simple camp tents. During the cool nights, it was equally as warm in this tent as in the straw hut; but in the latter, the wind blew through every crevice, so that the night-air caused a very perceptible draught: on the contrary, owing to the strong material of which the outside double covering of "Rhodes' Tent" is composed, this current of night-air nowhere penetrated through it, and I have been *repeatedly* assured of this fact by patients who had previously occupied the straw hut. For the more accurate observation of the variations of temperature I required a thermometer, but unfortunately had none.

It is to be observed that the temperature in this tent can be raised by the *lowering* of the inside cover in cold weather, and in hot weather, moderated, by *drawing it up*. I could however make no closer inspection on this point, since the weather continued, as before remarked, sufficiently warm in the tent, even during the night.

With respect to "Rhodes' Hospital Tent" resisting storm and rain, I can form no opinion from personal experience; but I think, from experiments which I made with the straw huts on the Düppler Höhen, and with the simple camp tent in the camp at Lüneburg, I may venture to state, that his Hospital Tent would be more secure against wind and storm than a straw hut, and amply as well against rain.

In conclusion, I must also mention that all the invalids who had occupied "Rhodes' Hospital Tent" spoke in high terms of it in every particular, and repeatedly of their having lived in it; besides, all the patients who had occupied both the straw huts and his "Tent" decidedly preferred the latter.

(Signed) DR. NEUBER,

Head Surgeon in the 2nd Infantry Regiment.

ADMIRAL SAUMAREZ drew attention to the fact that cotton cloth, when saturated, throws off the water, instead of allowing it to pass through; and that that was the great advantage of cotton over linen. He stated that a lieutenant in the navy, observing that air could not pass through saturated cotton cloth, had turned this knowledge to account in making a life-belt, which he found sufficiently strong to support him; that he himself had made one, and that several others had been made on the same principle from cotton cloth, and found to answer perfectly.

STIRLING LACON, ESQ. Though cost ought to be no consideration where the health of the men is concerned, will you be kind enough to give us a slight estimate of the cost of a tent constructed on the Government plan as compared with yours, both holding the same number of men ?

MAJOR RHODES. The Government single-poled conical tent costs about £3 15*s.*; a tent of mine, of the same size, would be about £9 9*s.* or £10 10*s.*, both accommodating the same number of men. Mine is of double cotton canvas, which of course increases the price; and then an extra expense is incurred on account of the ropes and the canvas being waterproofed by the present mode of waterproofing cloth, &c. The tents being covered with double cloth, the interior cloth would take a considerable time before its waterproof qualities would be much deteriorated, on account of the water not often touching it. My tents have been tested in Dublin and elsewhere *during very heavy wet weather*, and those tents were *perfectly dry inside*, during and after very heavy rains, on account of the double cloth. The Turkish soldiers' tents are all covered with double cotton canvas.

STIRLING LACON, Esq. I prefaced my question by saying that the cost ought not to be any consideration where the health of the men is concerned.

MAJOR RHODES. I may be permitted to remark, that, though my small field-tent is more expensive, yet my hospital tents are less costly than the Government hospital marquees, both holding the same number of men.

CHAIRMAN. Major Rhodes has, under an unpretending title, read a very interesting paper. The subject is no less important than interesting, when we consider the fact, (of which we are all aware,) that 80 per cent. of the deaths in the Crimea arose from sickness arising from the want of sanitary arrangements. Of course the difficulty in erecting the tents which have a pole in the middle is very considerable; and, if the men are putting the tent up during a storm, it is often capsized before it is finally erected. In Major Rhodes' tents the covering is not put on till the framework is up, and the covering of the tent is therefore comparatively easy. I think I should begin to build the framework from the top, though perhaps that is not the ordinary way of building; but it appears to me that if the top frames were first inserted in the round top, or head-piece, and then bent, the lower frames would be fixed easily into the ground.

MAJOR RHODES. I have tried it both ways, and I find that the best way is to erect it from the bottom. The frames of the Hospital, and other larger-sized Field-tents, are erected as the Chairman describes.

CHAIRMAN. Of course I do not pretend to be competent to speak as to that. . . . . I may add, that Major Rhodes has received a gold medal from the Emperor of Austria in testimony of His Majesty's high approbation of his (Major Rhodes') improvements in tents.

THE

Journal

OF THE

United Service Institution.

VOL. III. 1859. No. XI.

LECTURES.

Friday, March 25th, 1859.

Major-General LORD ROKEBY, K.C.B., in the Chair.

THE MILITARY CHARACTER OF THE GREAT DUKE OF MARLBOROUGH.

By Col. MACDOUGALL, Commandant Staff College, Sandhurst.

I HAVE chosen as my subject the Military Character of the great Duke of Marlborough, because I am led to believe that his genius is not by any means appreciated among his countrymen at its true value.

Within the limits of a single address, I can only propose to myself to direct your attention to a few of the events of his military career which bring out most prominently the distinctive characteristics of the man taken as a great military commander.

But he was equally great in politics as in war; and, indeed, no man can be a great commander without the possession of political as well as military genius—without that sagacious knowledge of men, personal ascendancy over their minds, far-reaching view, and unstinted confidence in his own powers, which placed Hannibal, Cæsar, Napoleon, Marlborough, and Wellington, with a few others, on a pinnacle apart.

My object at present is to show that Marlborough is worthily placed among the great men with whom I have associated him.

A very brief description of the general state of affairs in Europe, and of the composition of the contending parties, at the period under consideration, can hardly be dispensed with, because a very imperfect idea of Marlborough's labours, and of the difficulties he successfully surmounted, can be acquired from a consideration only of those operations which were under his nominal and immediate control.

In the year 1700, King Charles II. of Spain died at Madrid, having bequeathed the whole of his vast possessions to a grandson of Louis XIV., Philip of Anjou, who then assumed the title of Philip V. of Spain.

The principal continental powers acknowledged Philip V., excepting Austria.

The Elector of Bavaria not only acknowledged Philip's title to the crown of Spain, but entered into a cordial alliance with France; and being, at the time of the late King of Spain's death, governor of the Spanish Netherlands, the Elector secured for the young French prince the possession of that important country and of its numerous fortresses.

A glance at the map will show the commanding position which France thus acquired to coerce Europe, and how hopeless must have appeared at first sight the efforts of the coalition formed at a later period to curb the ambition of the French monarch,—of which the great Englishman was the animating soul, and by whose genius and patient fortitude alone the efforts of that coalition were brought to a successful termination.

France; Spain; Flanders; the greater part of Italy, comprising Savoy, Milan, Tuscany, and Naples; formed one close league in territorial connection with each other, and were, for all practical purposes, under the almost absolute direction of Louis XIV.

Thus Flanders, which had been the barrier of Europe against French ambition, became now an outwork of France for aggression against Europe.

In addition to the countries just enumerated, Bavaria formed an advanced post of immense advantage to France and danger to Austria, since it afforded a secure base from which the armies of Louis might threaten Vienna at the distance of only a few marches.

In 1701 Austria declared war against France, and sent an army into Italy under Prince Eugene, who at first obtained some success against the French forces.

In 1702 England and Holland joined Austria, and Marlborough, in his fifty-third year, was named Commander-in-Chief of the allied forces in Flanders. This appointment, combined with that of Ambassador-Extraordinary which he had previously held, and in virtue of which he had been the principal agent in organising the coalition, invested him with the supreme direction of civil and military affairs, so far as England was concerned, on the Continent.

The coalition was soon joined by many of the lesser German States, at a later period by Prussia and Denmark.

It was easy to foresee that the task of keeping together for any length of time a coalition of so many states, actuated by differing views of their individual interests, would be one of no common difficulty. And it may be said without exaggeration that their having been kept firm to the common cause was due to the personal qualities of Marlborough alone—to that ability, subtlety, knowledge of human nature, and personal influence due to his remarkable fascination of manner, which, added to his unsurpassed military genius, went to make up his grand and powerful character.

Besides the moral difficulties inherent in an alliance of so many states, the allies laboured under grave military disadvantages, their territories

being disjointed, and their several forces having to make long marches through neutral or hostile countries before they could unite. To produce a decisive effect they must strike at the heart of their enemy's power; but to reach France they must begin on the Rhine, with Holland as a base, and force their way through Flanders and through the barrier of fortresses with which the genius of Vauban had encircled the French frontiers.

Marlborough on more than one occasion, but particularly after the victory of Oudenarde, would, if unfettered, have marched on Paris, the road to which place seemed to be laid open by that victory. Had he done so, the experience of his whole military career, during which he never suffered a reverse, leads us to believe that he would have been successful; but he never could persuade the different members of the coalition that such a measure would be anything but the extreme of rashness; and even his worthy coadjutor Prince Eugene was startled at the boldness of the idea and objected to the risk.

At the commencement of the war the opposing forces were thus distributed:—

1. On the extreme French right Villars commanded an army on the Upper Rhine. Opposed to him was Prince Louis of Baden who commanded an Austrian army in the interest of the allies. His task was to maintain the lines of Stolhoffen, which guarded one of the principal defiles through the Black Forest, as well as to defend the other entrances from the Rhine through the Black Forest, against the attempts of the French.

2. Next, Tallard with a French force of 18,000 was posted near Kayserwerth to interrupt the siege of that place, which was to be undertaken by a combined Dutch and German force under the Prince of Saarbruck.

3. Next, the principal French army under the Duke of Burgundy was on the Meuse covering Flanders. To this was opposed the principal allied force, at first under the Earl of Athlone, afterwards commanded by Marlborough in person.

4. On the extreme French left a French force under the Marquis de Bedmar was opposed to the Dutch General Cohorn.

5. The Elector of Bavaria in his own country commanded an army in the interest of France, which acted as a bridle upon Austria.

6. In Italy the combined forces of France and Savoy, under the nominal command of Victor Amadeus, Duke of Savoy, were opposed to an Austrian army commanded by Prince Eugene.

Marlborough's first difficulty was to overcome the jealousy of Athlone and the Prince of Saarbruck at his being appointed to the chief-command; and, although their unwilling acquiescence was at length obtained, he found rivals in place of obedient tools in his subordinate generals. By Athlone, in particular, he was constantly thwarted under an affectation of deference; and the remainder, where they did not purposely thwart him from jealousy, did so by their extreme caution and timidity. Next he found himself subject to be controlled in all his operations by the Dutch field-deputies, without whose consent he could undertake no offensive movement, although these men were, for the most part, entirely ignorant of military affairs. Imagine Napoleon controlled by civilian deputies and timid or jealous generals. What would have become of the Italian

campaigns, of Montenotte, Lodi, Arcola, Rivoli, Marengo?—what of Ulm and Austerlitz? But to these trammels Marlborough was subjected during the whole of his command. For a striking illustration of this, I refer you to his very first campaign as related by Coxe, the details of which I cannot attempt to give in the brief time at my disposal. You will find that immediately on joining the army in 1702 he submitted three different plans for the consideration of the Dutch states, without whose concurrence, as I have said, nothing could be undertaken. Although every moment was of value, fourteen precious days were wasted in deliberations. At length, when he did obtain permission to advance, the general in command of the Hanoverian contingent announced to him that his troops could not move without the orders of the Hanoverian minister at the Hague. On reference to that functionary, it was found that among the conditions on which he could alone sanction the march of the Hanoverians was this one, that they should not be led across the Meuse. Of this Marlborough said, "I think we were almost as well to be without them as agree to it, as if we have not these troops we shall not have strength to act."

A reference to the Elector of Hanover had no sooner removed this difficulty, when a similar one arose with the Prussian contingent, which had to be disposed of in like manner by an appeal to the King of Prussia.

In execution of the plan which had been sanctioned by the States, Marlborough crossed the Meuse below Grave and advanced into Brabant, so as, by threatening their communications with France, to compel the French to withdraw from their forward position between Goch and Gennep.

On the first intelligence of this movement the French quitted their position, and, making forced marches up the right bank of the Meuse, crossed that river between Venloo and Ruremonde and struck across country in order to regain their communications.

But on the 2nd of August Marlborough occupied such a position that the French must either await his advance in a camp which was so badly chosen that their defeat would have been almost certain, or must expose their right flank to be attacked by him while marching over an open heath.

The French quitted their camp at dusk and, marching all night, were just entering the heath at dawn. Marlborough's troops were under arms and ready to march; the defeat of the enemy was certain, when the Dutch deputies refused their consent to the attack they had sanctioned a few hours earlier, and the French army accomplished its flank march within sight of the allies, scatheless, but in such haste and confusion that the deputies confessed a great opportunity of destroying it had been lost through their means.

A very graphic account of this affair is to be found in General Kane's Memoirs, pp. 33 to 35.

Now let us consider for one moment what would have been the effect on the general issue of the struggle, if Marlborough's arm, when raised to strike the blow on this occasion for which he had so skilfully laid his plans, had not been held back by civilian deputies. In India these gentlemen are called "political agents."

From what has been said it must appear more than probable, that the defeat of the French army under the Duke of Burgundy in 1702 would have been not less complete than was that suffered in 1706 by the combined French and Bavarians, at Ramillies. The moral effect of such a victory at the very commencement of the war, would unquestionably have been greater than was that of the battle of Ramillies, occurring after four years of varying success.

But the effect of Ramillies in 1706, was to clear Flanders almost to the French frontier; to make a regular "*sauve qui peut*" of the French garrisons, many of which surrendered without a blow, nay, to make Louis tremble for Paris itself, the road to which capital seemed to be laid open, so much so that Vauban was ordered to prepare a plan for its defence.

By the first event of the first campaign in 1702, if Marlborough had had his own way, the first four years out of the ten which it lasted would have been struck from the war.

Yet Marlborough was assailed by his enemies with the slander that he purposely dragged on the war from year to year from the base motive of putting money in his purse.

A second opportunity about three weeks after the first, and yet a third which presented itself on the 13th October, of inflicting a disastrous defeat on the French army, was lost in a similar manner through the interference of the Dutch deputies.

Yet although no crushing blow was struck during this first campaign against the French army in the field, the capture of Venloo, Ruremonde, Stevenswaart, Maestricht, and Liège, all on the Meuse, and all effected between the 18th September and the 23rd October, gave to the allies command of the navigation of that important river, and a secure base from which to operate in the next campaign against the right flank of the general front of the enemy; at the same time that it attested the activity of the English commander and the surprising resources of his genius, which could effect such results notwithstanding the fetters in which it was compelled to work.

In other quarters where Marlborough did not command, that is, in Italy and Germany, the coalition met with reverses.

Early in 1703 Portugal joined the confederacy; and although this accession was of great value since it exposed the weakest part of the Spanish frontier to an attack by land, it added greatly to the difficulties and labours of the British commander.

At the time when his own plans in the Netherlands occupied so much of his attention, and their execution required the employment of a force which he had the utmost difficulty in providing, he was charged with the thankless task of endeavouring to obtain, for service in Portugal, troops from the Dutch, the emperor, and the German States, all unwilling parties, who could not be persuaded that their individual interests could be in any way advanced by sending a single soldier away from the protection of their own frontiers. Marlborough was finally obliged to supply a considerable detachment from the force in the Netherlands to complete the Portuguese expedition; and he was harassed by endless importunities in his choice of generals and officers for that expedition, as well as by the captious spirit of the Portuguese court.

During the campaign of 1703 in the Netherlands, Marlborough's plans, always conceived on a scale which the minds of his coadjutors were unable to appreciate—and particularly one grand scheme for forcing the French lines, and the capture of Antwerp and Ostend—were thwarted by the misconduct of some of the Dutch generals, by the interference of the deputies, and by the virulence of the factions at the Hague. The war, reduced to one of sieges, was marked this year only by the capture of Bonn, Sluys, and Limburg.

On the part of the French, the campaign of 1703 had been originally planned by the court of Versailles on a scale worthy of the "Grand Monarque," and of the vast resources which he directed with absolute authority.

While Villeroi engaged the whole attention of Marlborough in Flanders, a great combined effort was to be made in Germany against Vienna. For this purpose Marshal Villars was directed to march with the army of the Upper Rhine through the defiles of the Black Forest in one direction, while from another quarter the French army of Italy, leaving a small force to observe the Austrians in Lombardy, was to enter Germany through the defiles of the Tyrol; and these forces, after uniting with the army of the Elector of Bavaria, were then to pour in one resistless torrent on Vienna.

Accordingly Villars, having secured a passage over the Rhine by the capture of Kehl, led his army through the Black Forest and was joined at Duttlingen by the Elector of Bavaria, who returned westward for that purpose after having defeated and driven the Austrian troops beyond the Inn and the Danube, and reduced Neuburg and Ratisbon on the latter river.

After this junction it was agreed that Villars should observe the Imperialists on the Danube; while the Elector with 15,000 men should invade the Tyrol, to open the passes by which the French army of Italy under Vendome must march to join him. But the sturdy resistance of the Tyrolese peasantry saved the empire. Vendome, coming from Italy, could not penetrate beyond Trent; while the Elector, coming from Germany, was defeated in endeavouring to force the pass of the Brenner and driven out of the Tyrol with considerable loss.

This miscarriage, joined to the defection of the Duke of Savoy from the French interest, necessarily deferred the grand effort against Austria to the succeeding year.

We are now brought down to the year 1704, that of the ever famous and admirable campaign of Blenheim, which would itself, even though it had been his only one, have established the right of Marlborough to be classed among the military Titans of the human race.

The plan above described became known to the English general through his spies. He perceived that the enterprise, if successful, would trample Austria in the dust and shatter the confederacy to pieces.

It is indeed difficult to conceive a more gloomy prospect than that with which the year 1704 opened on Marlborough, who alone with Prince Eugene appreciated the magnitude of the crisis.

Austria was in imminent danger. With a formidable insurrection existing in Hungary in the rear, where the rebels had gained considerable successes against the imperialist troops—threatened at the same time with

an overwhelming irruption of enemies in front—the defensive system of Austria was in a deplorable condition.

Every exertion had been made to raise levies and prepare Vienna for a siege; but with an impoverished country and an exhausted treasury every exertion was fruitless.

The Elector of Bavaria commanded the Danube from its source to the frontier of Austria. He occupied Ulm, Neuburg, Ratisbon, Passau, and Lintz, all on that river. His force was raised by the junction with Villars to 45,000 men, and it was to be feared that Marshal Tallard—whose army on the Upper Rhine had likewise been raised to 45,000 men, and who had lately reduced Landau and Old Brisach, which last gave him a passage over the Rhine—would march to join the Elector through the southern passes of the Black Forest, which were weakly guarded by twelve Dutch battalions stationed at Rothweil, aided by some militia and peasantry.

The force which the Emperor could oppose to the Elector barely amounted to 20,000 men, while the main army of the empire under Prince Louis of Baden guarded the lines of Stollhoffen, near Carlsruhe, which had been constructed to defend the entrance to the northern defiles of the Black Forest.

Besides these, a few scattered battalions of Hessians and Prussians were in the neighbourhood of Philipsbourg. It seemed scarcely possible to prevent Tallard from joining the Elector in Bavaria, and from operating on Vienna with 90,000 men.

Marlborough saw clearly that the fate of the confederacy must be decided in Germany; he therefore formed the bold design of entrusting the protection of Holland and of his conquests in Flanders to the Dutch alone, and, leaving in his rear the numerous fortresses and armies of the enemy, of hastening with every man, horse, and gun he could collect to the decisive point. His plan was to transport his army by forced marches from the Netherlands into Bavaria, and there—having united with Eugene, and having gathered up in his advance all the small detachments of the confederates—to overwhelm the Elector of Bavaria before he could be reinforced by Tallard's army from the Rhine.

But both the moral and physical difficulties to be surmounted in the execution of this scheme were of so grave a nature, that any mind but one cast in the very grandest mould, would have shrunk appalled from the prospect they presented. His first care must be to baffle the penetration alike of friends and enemies, as both were almost equally dangerous to the success of his project.

For his enemies, had they learned his intention, might easily have frustrated it by a vigorous effort. He must give the slip to Villeroi in the Netherlands, and to Tallard on the Rhine, the latter of whom would have intercepted his march, and the former would have hung on his skirts, had they been aware of his destination, while the consent of the Dutch as well as of his own government would certainly have been withheld, had their timidity been startled by the disclosure at once of the whole of his intended enterprise; he must therefore lead them on by degrees, and deceive them into a concurrence with his first measures, until they should find themselves too far committed to recede.

The first condition of success therefore was absolute secrecy as to his

real plan, which was shared between himself and Prince Eugene alone. He persuaded the English government to forward his views without disclosing their extent, to send 10,000 additional troops to the Netherlands, and to give subsidies to Portugal and Savoy, to enable them to maintain the struggle.

With the Dutch he had more difficulty. He repaired to the Hague, where he laid before the government a plan skilfully calculated at once to conceal and to promote his design, of taking the offensive vigorously on the Moselle with his own army, while the Dutch, under Overkirk, remained on the defensive in the Netherlands.

The consent of the States even to this plan was only extorted at length by Marlborough's declaring it to be his fixed resolve to carry off the English force to the Moselle without the Dutch auxiliaries, if they persisted in their refusal. Next he had to persuade them to furnish a sum of money to enable the Margrave of Baden to keep the field.

He next had to deal with the King of Prussia, a most exacting and troublesome ally. Marlborough flattered this prince so adroitly by affecting to make him a confidential communication of his plans, even to the length of specifying the intended disposition of his troops on the Moselle, and by addressing him as the deliverer of the empire, that he obtained from him a considerable increase of the Prussian contingent.

By these efforts he succeeded in raising the army which Prince Louis of Baden commanded at Stollhoffen to 30,000 men, and, having also provided for the defence of his conquests in the Netherlands, on the 19th of May he commenced his memorable march towards the Moselle. At his very first halting-place, on the 20th, he received expresses from Overkirk in one direction, and from Prince Louis at Stollhoffen in another. Overkirk begged him to halt because Villeroi had made a forward threatening movement. Prince Louis urged his joining *him* at Stollhoffen because Tallard threatened to cross the Rhine.

To satisfy Overkirk he halted for one day, while, to reassure Prince Louis, he directed the Prussian troops on the Rhine to move towards Philipsbourg as if to reinforce him, but with secret orders not to proceed beyond a certain distance.

On the 23rd at Bonn he had the vexation to learn that Tallard, having crossed the Rhine at Brisach, had succeeded in pushing a reinforcement of 10,000 men through the Black Forest to the Elector of Bavaria, and had then taken post near Strasbourg. He heard also that Villeroi from the Meuse was hastening after him to the Moselle.

Having crossed the Rhine at Coblentz, he reached Mentz on the 29th. He here disclosed his design to the Prince of Hesse, and persuaded him to send the battering-train he had collected at Mentz for the expected operations on the Moselle up the Rhine to Mannheim, as if now for the purpose of besieging Landau.

Hitherto his movements had held Europe in expectation, suspended the operations of the Elector of Bavaria, and perplexed the French commanders. His advance beyond the Moselle seemed to threaten the invasion of Alsace, while the despatch of the Hessian battering-train to Mannheim would appear to indicate the siege of Landau.

Villeroi, coming from the Meuse, accordingly directed his march towards Landau, and Tallard moved northward to join him.

Having thus set these two dangerous opponents on a wrong scent and secured a considerable start, the army which Prince Louis had commanded was left to watch them on the Rhine under the command of Prince Eugene, to prevent them, if possible, from crossing that river and reinforcing the Elector of Bavaria.

Marlborough was very anxious to have Eugene as his immediate colleague on the Danube; but the Prince of Baden, insisting on his superior rank, was transferred to what he considered the more important command, and it was with difficulty he could be brought to consent to share the chief command with the English general. It was finally settled that they should exercise the command on alternate days; thus Marlborough found himself saddled with a captious and incapable colleague.

Proceeding onwards from Mentz, Marlborough crossed the Neckar twice at Ladenburg and Lauffen, on the 3rd and 9th of June.

He had no sooner done so than his design burst at once on the minds of his astonished enemies.

On the 21st his whole army cleared the defilé of Geislingen, and on the 22nd united with the 20,000 men whom Eugene had previously commanded.

On the 24th the Allies advanced to Langenau and Elchingen. The Elector of Bavaria, who was at Ulm, withdrew to his entrenched camp at Dillingen. Marlborough's object being to strike at Bavaria, and by wasting his country to compel the Elector to abandon the French alliance.

On the 1st July the Allies passed within sight of the Electoral camp, and halted that night at a distance of fourteen miles from Donauwerth. This place was defended by 12,500 Bavarians who occupied the commanding heights of the Schellenberg, where they laboured night and day to strengthen the entrenchments.

On the 2nd it was Marlborough's turn to command. He was resolved to gain Donauwerth at any price as a place of arms for his intended invasion of Bavaria, and he determined to attack the Schellenberg that very day, notwithstanding that the intervening roads were heavy with continued rains and the army was encumbered with a long train of artillery, because he felt sure that if he failed to do so on the 2nd, the 3rd would be wasted by Prince Louis in irresolution, and that the delay of twenty-four hours would enable the enemy to complete his works and to receive reinforcements, in which case he said that the delay of every hour would cost the loss of 1,000 additional men in the assault.

The result is known. Although unable to bring up his men till 4 P.M. he assaulted Schellenberg at that late hour, carried it after a desperate conflict, in which 8 generals, 11 colonels, and 1,500 of other ranks were killed, and 4,000 wounded.

The Elector, who crossed the Danube at Dillingen and marched by the south bank to the relief of his garrison, was only in time to witness their defeat, and withdrew to Augsburg, leaving his dominions at the mercy of his enemies.

On the 10th of July the allies, having crossed the Lech at Gunderkingen, entered Bavaria.

On the 18th the army occupied Aicha, but Marlborough's design of besieging Munich was prevented by the failure of Prince Louis to provide

a battering-train as he had promised to do. 3,000 cavalry were, however, sent on to burn and destroy to the very gates of the capital; a barbarous proceeding, adopted for the purpose of forcing the Elector to make terms.

Meanwhile Tallard had crossed the Rhine with 35,000 men, and, eluding Eugene, joined the Elector of Bavaria on the 5th August.

Eugene, marching from the Rhine in a parallel direction, arrived at Hochstett at the same time with 18,000 men, having left 12,000 to watch Villeroi.

Prince Louis of Baden was now persuaded to undertake the siege of Ingolstadt, and was detached on that service with 20,000 men.

There was now a danger lest the enemy, being very superior in force to either Marlborough or Eugene singly, might beat them in detail.

On 9th August, it being ascertained that the Elector and Tallard were in full march from Augsburg to Dillingen, in the evident design of there crossing the Danube and overwhelming Eugene's 18,000 men at Hochstett, arrangements were made for a concentration in front of Donauwerth. Eugene's army fell back behind the Kessel river, where it was joined by that of Marlborough on the night of the 11th.

On the 13th Marlborough and Eugene attacked and defeated the Elector and Tallard at Blenheim, and thus terminated this brilliant campaign, which appears to me to be one of the very grandest military achievements on record.

No similar instance exists in history of a mere general, answerable to his own sovereign and to his allies, taking on himself such an immense responsibility. Alexander and Napoleon, for the prosecution of their great projects, wielded absolute power. Hannibal, though opposed by a faction at Carthage, was absolute in Italy. But what Marlborough did was in direct contravention of the authority under which he acted; and it was only in conquering their enemies that he conquered the approval of his employers.

Historians relate with wonder how Napoleon, on the 1st September, broke up his camp on the heights of Boulogne, set in motion eight corps by various routes to the Danube, and terminated a campaign of one hundred days with the crowning victory of Austerlitz.

Napoleon's march was of his own troops, whom a nod from him sufficed to move. That of Marlborough was the march of allies tricked by degrees into carrying out a plan with the secret of which they were not entrusted, coming from various quarters, with orders from different sovereigns; the command divided on alternate days with an incapable colleague; and yet, in the course of less than a hundred days, Marlborough, too, had transported the confederate troops from the Meuse to the Danube, routed the allied French and Bavarians at Blenheim with the loss of 40,000 men, conquered Bavaria, dethroned the Elector, and saved the empire from destruction.

In making war there is one great principle or rule, and only one, which is of universal and arbitrary application, viz. that you must be superior in force to your enemy at the decisive point and time; or, where actual circumstances render that an impossibility, then it is required to bring up to the decisive point every man, horse, and gun that can by any possible foresight and combination be arrayed there.

Other rules there are with respect to the manner of applying the first, having reference to the preservation of your own communications, and to the intercepting those of your enemy, besides many maxims which are all subject to modification by actual circumstances, and particularly by moral considerations.

But the genius of a great captain is a law to itself. He takes counsel of his own inspiration alone, and, unfettered by arbitrary rules, he keeps his eye fixed on the object of all operations—success—and presses on to the goal, sensible that no course of action can be at variance with military principles which lead him to it.

Marlborough's comprehensive view embraced Europe as one vast battle-field, of which he saw that Bavaria was the decisive point; casting off all communication with his base, like Hannibal in his invasion of Italy, he threw himself into the midst of enemies, relying on his own genius to organise a secure base of operations in a hostile country; and this he accomplished.

His military genius was peculiarly that of a strategist in the literal meaning of the term; and he employed on the contracted theatre of a field of battle precisely the same weapons of finesse, masterly combination and skilful execution, which win our admiration in his great strategical operations.

He appeared to deal with the minds of his opponents at will—to command them to believe what he desired them to believe—and having, by the subtlety of his art, led them to weaken the point which he perceived by intuition to be the decisive point of the field, he then directed his battalions and squadrons on that point with irresistible force and ability.

At Blenheim, by a feigned attack on the village of that name, Marlborough induced Tallard to draw nearly the whole of his infantry from the centre, and to shut it up uselessly in the village, so that the attack which Marlborough prepared against the centre was successful and decisive.

He was not content with mere victory; his measures were always taken with a view to inflict the greatest loss possible on his opponents. At Blenheim, by breaking the centre, he cut off nearly the whole of Tallard's right wing from the only road by which it could retreat. 11,000 prisoners were taken in Blenheim alone; Tallard himself was captured, and the total loss sustained by the French and Bavarians in the battle and subsequent retreat, is computed at 40,000 men and 47 guns; a loss greater than any which France ever after sustained until Waterloo.

At Ramillies the Tomb of Ottomond on the French right was the point which Marlborough's eye marked as decisive. To induce Villeroi to weaken that point he ordered a feigned attack on the French left. A marshy stream, difficult to cross, separated the French left from Marlborough's right which was posted on high ground that sloped both ways, viz., down to the stream in his front as well as to the rear of his line. Marlborough's infantry of the right wing in two lines, supported by cavalry, marched down the slope towards the stream as if about to cross. Villeroi, alarmed for his left, reinforced it by a considerable body of infantry from his right. Marlborough waited till the enemy's movement was nearly completed, and then ordered his right to retire to the elevation

it had quitted. With his first line he halted on the crest and showed front to the enemy, but he carried his second line over the height to the rear, and moved it rapidly, concealed by the nature of the ground, to his left. He thus strengthened his attacking force at the same time that he induced Villeroi to weaken the point he was about to attack; and the victory was principally owing to this circumstance.

The time will only admit of my directing your attention to one other operation, which is a wonderful instance of the power which the English general wielded over the minds of his opponents. I allude to the passage of the French lines of Bouchain in 1711. The details will be found well related in Coxe.

Marlborough selected as the point where the passage of the lines might be most easily effected, one which was defended by an important fortified post named Arleux, on Marlborough's side of the lines. This post was held by the French, and he therefore resolved to take it ; but for the success of his general plan it was not enough that he should capture this fort, because if he should do so, and either retain it or demolish it himself, the attention of Villars the French general would be drawn to the point, and he might so guard this part of the lines, which was very strong, that success by main force would be hopeless.

Marlborough must if possible not only divert the attention of Villars from the neighbourhood of Arleux, but he must induce that marshal to demolish the defences of the post himself. To effect this, which seemed difficult enough, the duke had recourse to the following masterly stratagem. He assaulted and took Arleux, to show Villars he could capture it when he pleased; he then considerably enlarged and strengthened its works to delude Villars into the belief that he valued it as a defensive post.

Having so done he left Arleux and its garrison to its fate, and carried his army to a distant part of the lines which he ostentatiously threatened to attack, feeling confident that Villars would then retake Arleux, and, finding it on account of its increased extent to require a larger garrison than he could safely spare from the defence of that portion of the lines menaced by Marlborough, that the French marshal would then demolish a post which his adversary seemed to value.

It happened according to Marlborough's calculations. Arleux was attacked and captured by the French, with its whole garrison. Villars was greatly elated, while the English general pretended the deepest mortification. He shut himself up in his tent, with exquisite dissimulation changed his usual courteous demeanour and became morose, and declared to all who had access to him that he would repair the disgrace he had sustained in the loss of Arleux, by attacking the enemy's entrenchments in his front at all hazards.

He soon had the satisfaction of learning that Villars had evacuated Arleux and demolished its defences, and, leaving that portion of the lines destitute of troops, that he had concentrated his whole force behind the part menaced by Marlborough.

To confirm Villars in his error, Marlborough, attended by his generals, made an elaborate reconnaissance of the enemy's position in full view of the French army. He rode along the front within cannon shot; stopping occasionally, and pointing to different parts of the entrenchments, he care-

fully explained to his generals the direction their several columns should take in advancing to the attack.

Having thus completely deceived both friends and foes, and effectually prevented the possibility of his real design being communicated to Villars by confiding it to no one, he gave orders for the troops to form for the assault of the lines at tattoo that evening, and intimated to the officers in command of the separate columns that they were only to move off under the guidance of staff officers who would be sent for that purpose.

The army was formed accordingly at tattoo beating in columns of attack; but, instead of advancing, they filed off to the left, the attention of the French general being occupied by a demonstration made by the light cavalry in front of his left.

Marching all night, Marlborough, at eleven o'clock on the following morning, passed the lines unopposed near the ruined fort of Arleux with a considerable body of cavalry and infantry.

Before dark the same evening his whole army occupied a strong defensive position on the French side of the lines; and this celebrated barrier, which Villars in writing to his sovereign had called the "ne plus ultra" of the English general, was broken through without the loss of a man.

Like most great generals Marlborough invariably took the initiative, and compelled his adversary to follow it, and no commander has ever been more enterprising.

His care in providing for the comfort of his troops was unceasing, and he was, in the words of Mother Ross, a famous camp follower, whose adventures were written by Defoe under the name of Mrs. Christian Davies, "entirely beloved by all the forces, not only for his courage and conduct, but equally dear to us all for his affability and humanity."

In estimating the greatness of Marlborough, we ought to take into account the age at which he first commanded an army in the field and his physical infirmities.

It is strange to observe how late in life the great work for which they have been born comes to some men.

If Wellington had died at thirty-four he would still have left a lasting name in the history of British India. At forty-five he had swept eight French marshals out of Spain, and broken the last hope of Napoleon at Waterloo; but if Marlborough had died at fifty, he would scarcely have furnished a paragraph for the most voluminous history that ever was written. His great deeds were done, his great name earned, when falling into the sere and yellow leaf; when his strong frame was beginning to fail; when, as he himself writes, "My eyes are so bad I do not see what I do;" and when "I am habitually mad with headache." In another place he says, "I am troubled with cold fits of ague, and with gout." And again, "I have become so lean, that, if not well nursed in the winter, I shall certainly be in a consumption."

Yet, with these ailments, he contrived to be seventeen hours on horseback at a time when, he writes, "If I were in London I should be in bed in a high fever."

Then we see him at the age of fifty-eight at the siege of Lille, doing the double duty of commanding Eugene's army as well as his own, and before Ghent in a Flemish fog at Christmas, paddling in the wet trenches, and

earning so great a cold that he says, "It is very distressing to me to hold down my head."

All this and moreover at the same time to manage Dutch, Prussians, jealous subordinates, political agents, kings, queens, and emperors, English Whigs and English Tories, and, hardest task of all perhaps, the Duchess of Marlborough, was, it will be admitted, no child's play.

To sum up his military achievements; in twenty campaigns—ten of which were successive—he passed all the rivers and lines he attempted, took every town he invested, won all the battles he fought, and was never surprised by the enemy.

I may fitly conclude with a quotation from Addison's poem, "The Campaign." The particular lines were inspired by Marlborough's personal demeanour at Blenheim.

'Twas then great Marlborough's mighty soul was proved,
That, in the shock of charging hosts unmoved,
Amidst confusion, terror, and despair,
Examined all the dreadful scenes of war.
In peaceful thought the field of death surveyed,
To fainting squadrons sent the timely aid,
Inspired repulsed battalions to engage,
And taught the doubtful battle where to rage.
So when some angel by Divine command
With rising tempests shakes a guilty land,
Such as of late o'er pale Britannia passed,
Calm and unmoved he drives the furious blast,
And, pleased the Almighty's orders to perform,
Rides in the whirlwind and directs the storm.

Friday, April 8th, 1859.

Captain E. G. FISHBOURNE, R.N. C.B., in the Chair.

NEW ZEALAND CONSIDERED AS A FIELD FOR THE EMIGRATION OF MILITARY MEN.

By Captain C. CHESNEY, R.E., Professor of History at the R. M. College, Sandhurst.

I DO not purpose to occupy your time with a lengthened apology for the subject which I have undertaken to bring to your notice. So large a number of the better class of emigrants is drawn from among the officers of the army, and of this number there are so few who decide on their future home without at least some thoughts of New Zealand, that I trust a brief account of that colony, its advantages and disadvantages to the intending settler, may not be deemed inappropriate to the lecture-room of this Institution. There are, indeed, a variety of printed works on this very subject; but there are, I am sorry to add, only a few of them which have not been published from interested motives, and I have met with none that, in my opinion, fairly puts before the reader the whole difficulties which he should be prepared to meet.

I should here explain that the value of land, cattle, and all such property, in a newly-settled country, rises naturally in a regular ratio with the increase of its population: each new arrival from the mother country adds a fractional increase to the selling price which the earlier settler can obtain for his farming stock, land, or house. Hence there is a constant inducement to the production of books, the object of which is to draw as many people as possible to the colonies they describe, and which in fact are no more to be relied upon than any other of that large class of advertisements called "puffs."

In the account I am about to give, I shall strive to tell the simple truth, without partiality or concealment, believing, as I do, that the claims of New Zealand to popularity as a colony require no factitious aid from tongue or pen, and that her real natural advantages are sufficient guarantees for her future growth and greatness.

The subject before us seems naturally to divide itself into the following heads:—

1. The consideration of the colony as a whole, and in comparison with the other important members of our colonial system.

2. A special account of all of the provinces, such as may be useful to those who are anxious to become acquainted with the local peculiarities of each.

3. Remarks applicable to persons who may seriously entertain the thoughts of leaving England to seek a home in New Zealand.

Let me now proceed to the first section of our inquiry.

New Zealand lies, as you are aware, not very far from the point on the

globe called the Antipodes of Great Britain, to which island it bears in some respects a considerable resemblance, running, as it does, in its main direction, from north to south, and thus occupying a considerable space of latitude, which produces a corresponding difference of climate between its two extremities. The acreage, or area, of New Zealand is remarkably near that of our own island; indeed, it remains for some more accurate survey than those existing to be made, before we can ascertain whether it is a little more or less than that of Great Britain: at present we only know that it is the same within a million or two of acres. The resemblance between the two countries has been considerably exaggerated, and I think its chief points are the two just mentioned.

And now to speak of the differences between them.

New Zealand lies much nearer to the equator than our own island, its northernmost point being nearly in lat. 34° S., whilst the southernmost is in lat. 47, instead of its extending from 50° to 59° N., as does Great Britain; its centre is therefore about 850 miles nearer to the sun than that of the latter. I need hardly add that the climate is therefore warmer; but I believe very few people at home are aware how great the difference is, and I may state at once that the north of New Zealand possesses (I do not say enjoys, for that must ever be a matter of taste) a climate warmer than that of Naples. The summer is very hot indeed, the heat being quite tropical, and in some years unbroken for four or five months by a single refreshing shower. The winter is very mild, and is chiefly diversified by violent storms of wind and rain seldom continuing more than twenty-four hours; or by a few days of really cool weather, when the wind sets in from a point due south, and, being accompanied by a cloudless sky, produces an elastic bracing feeling of cheerful health and strength, which I doubt if any climate can surpass, or even equal. I have not been in the most southern settlements of the island, but, although both winter and summer there are much more like those of England, the furthest point as yet attained, which is nearly at the extremity, has not brought the colonists into a climate as cool as even the very warmest parts of the south shore of Devonshire.

New Zealand is much more completely surrounded by open ocean than Great Britain. It results from this, that it is free from that great difference of moisture between the winds from different quarters, which is so severely felt by all invalids at home. The easterly winds more generally bring rain to New Zealand than the westerly, for in that hemisphere most of the ordinary conditions of nature with us are reversed; but there is no perceptible, much less painful, difference in the feelings produced by either.

New Zealand is not one island, as most persons know, and the map shows; it is divided, just in the centre, by the narrow slip of water called Cook's Straits, which in one place is only seven miles wide. The very stormy nature of this passage renders it a much more important division than would at first sight appear, and makes it a considerable barrier to communication from the northern half (or Northern Island) to the southern portion, which is commonly called Middle Island, from there being to the south of it, again, the third insignificant division, named Stewart's Island.

It has been said that the area of New Zealand is very nearly equal to that of Great Britain, but it would be a great mistake to conclude from this that the extent of cultivable land in the former is the same as that in the latter. The fact is far otherwise. The northern island contains, especially towards the Cook's Straits extremity, great chains of mountains, which are never likely to be inhabited in a newly-peopled country, where there is a choice of more favourable localities. And this is far more the case in the middle island, where the whole western and northern portions are occupied by snow-covered ranges perfectly alpine in their character, and which, though they leave fine plains to the east, yet take up a very large part of the space which the island covers. Indeed New Zealand, generally speaking, is of a more mountainous character than any country I am acquainted with, except Switzerland, and there is no probability that it could at any period support an agricultural population at all equal to that maintained by Great Britain.

Another distinction in the features of these two countries is to be found in the superiority of New Zealand as to its supply of water. Throughout the country the number and size of the streams is remarkable, even in those parts which are not of an elevated character; whilst the noble navigable rivers which more markedly intersect it, and are fed by the snows and rains of the mountain ranges just referred to, are matter of admiration to every traveller, and also of wonder, as compared to the moderate extent of the land which they traverse. A further increase to the present scattered population will lead assuredly, among other internal improvements, to a great development of the natural resources thus bountifully supplied for inland communication.

From the subject of rivers there is a natural step to that of harbours, and, with regard to the latter, which are of course a necessity in the foundation of new settlements, no country has been more favourably dealt with than that we are speaking of. There are but few portions of the coast which are not richly supplied in this respect. In speaking of the provinces I shall have occasion to refer to some of the principal harbours, and I may mention generally that there are many others, more or less frequented, which are so favourably placed as to give sure promise of their future value, as settlements become multiplied.

And now to speak of that point, which should surely be the first attended to by those who wish to know whether a colony is suitable as a residence for themselves or others in whom they are interested, viz. the climate. Its degrees of heat and cold have been already spoken of in a general way, but the question remains, What is its practical effect upon the race who are now peopling it so rapidly? Now the assertion has been often made that it is finer than that of England, and it has been supported by statistics of the amount of cases of disease and death occurring at certain of the settlements. If this be intended to mean that the majority of emigrants will find it more suitable to their constitutions than that in which they were brought up, I believe it to be a most decided fallacy, and founded on an erroneous basis. Such statistics, made in the infancy of any colony, are most unreliable. The fact of the population of both sexes being mostly composed of persons in youth, or in the prime of life, the absence of those epidemic diseases which cause so much mortality at

home, but do not find their way across the ocean for years after the foundation of the new settlements; the healthy open-air life which agricultural and pastoral pursuits enforce; these causes are quite sufficient to produce a mistaken belief in the supposed superiority of the newly-tried climate, and, such an error once arisen, those who have cast their lot in it are naturally very unwilling to abandon their delusion.

The fact is that most Englishmen find the air of New Zealand much more warm and enervating than they supposed; and it is, like all other similar climates, less suited to their constitutions than the rougher and more bracing atmosphere of their native land. I should except, however, from this view, those who cannot bear the cold of an English winter, or the varying temperature of an English spring; and particularly the large class of sufferers from a tendency to pulmonary complaints. Such persons would, undoubtedly, in most instances, gain in health by a removal to New Zealand. So also would many, who could exchange a sedentary life at home for a farm or sheep-run in the colony.

Another matter which much concerns those who are about to make their future home in a distant land, is the quality of the individuals with whom they will have to mix. Now it is certain, though the truth may not be a palatable one, that in none of our newly-settled countries is there to be found so high a standard of morality as might be desired. The rapid acquisition of property seems to make men all the less scrupulous as to the means they employ for this end: and much of the deficiency now spoken of is also to be ascribed to the absence of the constant restraint, which the state of society at home imperceptibly imposes on each of its members. From this last cause doubtless it is that the vice of intoxication forms a glaring and painful feature among colonial habits in each of the new Anglo-Saxon communities. Now it cannot be asserted that New Zealand is an exception to the evils just mentioned. And yet it may be safely said that there are more settlers of a superior class and a right tone of mind in her settlements to counteract them, than can be found in any other of our colonies. The influence of these men on the habits of the generation rising around them, and its importance to the future moral and religious welfare of the country of their adoption, cannot be overrated. Nevertheless, even in New Zealand, drunkenness prevails to such an alarming extent that those who carry with them in their emigration the tendency to that most fatal vice, may be said to go to certain misery, ruin, and probably an early death.

Of the soil and farming capabilities of the country, I shall have occasion to speak more particularly in my account of the different provinces. The valleys and plains are almost without exception fertile; the heavy timber of the north, and the rich natural pasture of the centre and south, both alike attest this fact, and offer their several inducements to the axe and plough. The forests of Taranaki and the grassy plains of Canterbury are alike capable of affording rich repayment to continuous and rightly-directed labour. Having said thus much, I would caution my hearers against putting faith in the exaggerated eulogiums published, which in this instance also have gone far beyond the truth, and would make it appear that the very exceptional cases of sixty bushels of wheat being produced from, or five sheep maintained by, one acre, were the rule by which the settler might make his calculations.

When we approach the subject of the scenery of New Zealand, we touch upon a point in which she compares most favourably not only with Great Britain but with almost any other land that the sun shines on. If the most varied combinations of streamlet and valley, hill and wood, of snow-capped mountain and noble river, with bright blue sky over all, can charm the eye and thrill the heart, there is no country where this simple pleasure may be more completely enjoyed. The forest heights which rise from the fair plains of Taranaki, crowned by the mighty cone of Mount Egmont, piercing the skies; the huge mountain ranges which seem to bar in the Bay of Nelson and Queen Charlotte's Sound from landward approach; the picturesque green hills which surround Wellington and her harbour; these, and many other such views, can never be forgotten by the soul that has once been filled with their beauties. Were New Zealand within such a distance as to make it accessible to tourists, the more adventurous class would soon discover that, both in point of lovely scenery and of natural curiosities, there are but few parts of the world so well worth a visit.

As to animal productions, a by no means unimportant matter to the sportsman who enters a new field, New Zealand does not hold out rich promise. When Cook first visited its shores there was no quadruped in the island except a very small rat, now supposed to have been exterminated by its stronger European cousin. The pigs which he first imported have increased largely, and form a great article of food with the native population, and also supply some fair wild-boar shooting (for riding through a New Zealand forest is out of the question) in those parts where there is no native tribe near to lay claim to the remains of the quarry; in the neighbourhood of their pahs (or villages), however, it would be a most useless and expensive amusement to slay a stray grunter. Having mentioned this, and that there are abundance of wild fowl on the rivers, wherever they are left unmolested, and a few quail in some of the more open country to the south of Cook's Straits, I fear I have exhausted the list of sporting resources. One hears of pigeon-shooting; but this should rather be called pigeon-killing, for the woodpigeons of New Zealand are in the habit of gormandising during the seasons of particular berries till they become nearly incapable of movement, and the fortunate individual who discovers a flight of them among the thick branches of the forest—and to do so is no easy task, so dense is the foliage—may frequently fire several shots, and bring down his particular bird each time, before the rest make up their minds not to be killed, and leave the scene of their repast.

There is no animal in the colony to correspond to our deer, hare, or rabbit; nor any bird of the grouse, partridge, or pheasant kind. An enterprising individual has lately imported a number of the latter species into a rather out-of-the-way part of Auckland, where they were tolerably undisturbed, and the result, in a very few years, has been so vast an increase as to show that the climate and vegetable food proper for them are there already, and it only remains for man to supply the deficiency of nature in this respect. So with the rivers. It is very hard for the traveller who looks on those numerous streams which intersect the island in every direction, and give fresh beauty to each turn of every valley, to

believe that their waters are nearly destitute of fish—yet so it is. Eels in abundance, and a very small, sluggish species of trout, which does not rise to the fly, are all that they yield to piscatorial research. The man who could succeed in conveying the spawn of the salmon and the trout uninjured to the rivers of New Zealand, would confer a most weighty benefit on the future generations of its inhabitants.

Most of my auditory are aware of the leading characteristics of the native race of New Zealand, called there always by their own name of Maori; but the popular idea of them in England represents rather their past than their present condition. I saw, only a few days since, an elementary book upon geography, very recently published, in which they were spoken of as a race of cannibals. Now the last act of such a nature as could cast this stigma on them occurred seventeen years ago, and, so far from there being prospect of its being ever revived, I was present at an internecine warfare of two of the tribes in 1855, when the wounded and slain on each side were allowed to be removed by their friends during a sort of armistice made for the purpose, and were taken away accordingly without more approach to insult or mutilation than Frenchmen would receive under similar circumstances at the hands of Englishmen. The number of Maories has been variously estimated at different times within the last few years as being between 80,000 and 50,000. It is probable that the last estimate is the safest, and more particularly so now, as within the last few years various European epidemics, imported by emigrants, have made fearful havoc among them. They get the measles or influenza, but will not submit, even where there is advice for them, to the necessary care and treatment, and so perish wholesale. It is painful to pass through their villages and observe how very few children there are in proportion to the number of adults. Owing to this cause, and also to the fact that the mixture of the two races on the borders of the European settlement seems, for some cause or other, to be very unfavourable to an increase of population, there is, it is to be feared, a steady diminution of this noble race in progress, which threatens before long to annihilate them altogether. It is not in any way owing to any want of inclination or power on their part to adapt themselves to the habits of civilisation; on the contrary, they wear the clothes, raise the food, and use the tools, ply the machines, and navigate the vessels of the white man, and have adopted his religion, and the higher morality it induces, so honestly, that, as average Christians, they may well bear comparison with any community of Europeans. Even the greatest difficulty in the way of their complete civilisation, their custom of holding food and all such products to be not an individual property, but common to all the tribe of the possessor, even this is waning year by year, supported though it be by all the force of national habit, and by the influence of all who would indulge their personal indolence.

The Maories are large producers of corn, potatoes, &c. on their own land. They also add considerably to the supply of labour in the northern island, which is their chief abode, by their readiness to undertake odd jobs for the settlers. This desultory mode of working suits their habits well; but they have not as yet become trained to systematic labour, and cannot be induced to follow continuous employment as farm labourers or house servants. They use and rear with success all sorts of domestic

animals, and are passionate lovers of horses. Of these they now breed as well as import many, and, as they ride recklessly up and down the slopes of their native hills and ravines, they promise to become almost as equestrian a nation as the mountaineers of Circassia. I must not trust myself to speak further of this interesting people, of whom I believe most inquirers rightly assert that they are far superior to any of the aboriginal races we have encountered elsewhere. In concluding this notice of them, your attention should be drawn to the fact that they are all, with the exception of a few hundreds, located in the northern island, a great portion of which is recognised as their property, whilst they have no claim of importance over any part of the lands in the middle island. This circumstance has, as you will presently see, a powerful influence on the prosperity of certain of the settlements.

To return to the general subject. We have been speaking hitherto chiefly of the differences between Great Britain and her young daughter in the Antipodes, but this part of our subject would be very incomplete if we did not endeavour to make some comparison between the latter and those other great colonies which attract the attention of the emigrant. I really believe that with the exception of her greater distance from the mother country, and the want of game for sporting, there is scarcely a point in which New Zealand does not contrast with advantage. Consider but for a few moments the climate of New Zealand, where an open-air working life may be carried on with advantage to the health as well as to the farm from year's end to year's end; where the settler can turn out sheep, cattle, or horses, to feed untended, without shelter, in winter or summer, undeterred by frost, heat, drought, or fear of too great humidity; where every valley has its stream for use and ornament; where there is no snake or reptile, or beast of prey of any sort, to be feared or guarded against. And then compare it with Canada, and her five months of winter frost, stopping every attempt at farming operations; or Australia and her torrid riverless plains, burnt up by a sun as fierce though not as deadly as that of India; or the dry wastes of the Cape, with their innumerable poisonous reptiles and fierce wild beasts; and we must decide at once that there is no colony which offers the same advantages to the steady, quiet settler who goes out predetermined to win by his labour a peaceable and smiling home in a new land, for himself and his heirs.

I have purposely omitted speaking of Van Diemen's Land, a country too much filled up already to offer the prospects which should tempt the emigrant. It may be here remarked that the equably warm temperature of New Zealand, and the comparative moisture of its atmosphere, appear to be the most favourable possible conditions to the rapid and florid growth of trees, shrubs, and flowers. Hence a few years' planting and gardening around a house will make more show than four times the period would in England. A switch of willow, for instance, stuck into the ground, will in three years form a noble tree, sufficient to overshadow a small house. As to the finer sorts of such plants, as geraniums, verbenas, and fuchsias, they grow with a luxuriance and strength which must astonish every lover of flowers who sees them for the first time.

Add to its natural advantages the fact, that various circumstances, especially the expense of the long passage out, have combined, and do still combine, to take there a class of settlers of a higher and better order than

can elsewhere be met with; and it will appear that not only in natural features, but in respect of its social advantages, New Zealand may fairly claim to stand first among the great colonies which invite our surplus capital and unemployed hands. It is a striking fact in corroboration of this view, that while in Australia, with all her boasted advantages, the traveller cannot fail to remark a constant yearning after an English home, and will hear frequently an avowed intention of leaving the colony as soon as sufficient money has been made to allow of retirement from it; in New Zealand the settler has no such dissatisfied longing, or wish to give up his adopted land; on the contrary, his object seems usually to be to persuade as many as possible of the friends he has left behind to follow and join him, and thus complete his satisfaction with his new abode, by giving, in their society, the only charm he finds it wanting in.

We have now to leave the general description of the island, in order to enter upon the second head of our subject, and to remark upon the peculiarities of each province, and its relative drawbacks and advantages. I would here remind you that a seventh province has been lately carved out of that of Wellington, and added to the six into which the Constitution Act and previous custom had originally divided the colony. I propose to take them in succession, commencing with Auckland, which lies the northernmost, and has a right to our first attention, as it contains the present capital, and is the most populous and richest of the whole.

Auckland, the town after which the whole province is named, was founded in 1841 by Governor Hobson, who very properly removed the seat of government from the inconvenient and out-of-the-way situation in which it was before placed, at the Bay of Islands, some 100 miles further to the north. His choice was at first condemned by many, for the scenery and the soil around the little metropolis are neither of them as attractive as those of many other parts of New Zealand, but events have proved the wisdom of his selection.

Fronting the town, which faces the east, is one of the most commodious harbours in the southern hemisphere, good in itself and easily accessible, whilst a chain of islands, lying considerably seaward, not only protect its approach, but shelter the coast communication for many miles to the north and south, thus affording extraordinary opportunities for the development of local traffic. But this is not all: from the western side of the island there penetrates, in the direction of Auckland, a large land-locked sheet of water, called the Manukau, one branch of which reaches to within seven miles of the town, which is thus placed within the easiest reach of the whole coast on either side. The entrance to the Manukau has a bar, but there is depth of water on it at high tide to allow a moderate sized vessel to pass over in almost any weather. This approach has been for years used by both steam and sailing vessels, and will doubtless be always of the greatest value to the trade of the town, as it saves a passage of 400 miles round the north of the island, to the harbour of Auckland, to any vessel approaching by the western coast. The Manukau is also already very much used for local inland navigation, and in this respect will be of increasing importance, inasmuch as in one part it approaches to within eleven miles of the great Waikato River, the

natural highway to the southern and richest parts of the province, the noble stream of which, navigable for 150 miles, is thus only removed from Auckland by a sail across a lake and eighteen miles of land carriage. One of the few macadamised roads of which New Zealand boasts as yet, connects Auckland with the Manukau; so great, however, is the difficulty of securing regular labour for such purposes in the colony, that this road was only completed within the last four years.

The farming land about Auckland is not very inviting, being a stiff clay, which requires much labour to be expended on it in order to yield a good return. The extraordinary demand for supplies of all things eatable, at the Victoria gold diggings, during the gold fever of 1853-5, and the extravagant rise in prices which it produced in all the adjacent colonies, acted particularly at Auckland, where there are such great facilities for exporting. This made the value of farms, houses, and stock go up to exorbitant rates, and produced an unnatural degree of sudden prosperity among the agricultural population, which was succeeded by a rather depressing reaction, from which the settlement has only lately recovered.

There is some very good land to the north of Auckland, to be reached by coasting to the different small harbours, which lie scattered thickly in that direction. Towards the Bay of Islands, and along the narrow part of the Island, which terminates in the North Cape, the country is hilly, and not very improvable. But the great natural resources of this province lie towards the south, where the rivers Waikato and Thames, and some of the more remote harbours, as Kawhia, lead into fertile districts of unbounded extent, where the natural grasses, which do not grow on the heavier lands to the north, are first met with. Settlements far in this direction have already been founded, but have not increased as rapidly as might be, as the Government have not yet extended to such a distance the system of land purchase from the native tribes, which has lately thrown open some very good blocks of land nearer to the capital. I may refer, as an instance, to the fertile valley of the Wainku, situated between the Manukau and the Waikato, which was only opened for sale in 1856, and is already largely settled.

The Maories in this province are, generally speaking, by no means unwilling to part with their rights to such land as the Government wishes to purchase, but there is a natural desire, on the part of the latter, not to cause mistrust by overdoing their part, and driving the natives into too narrow or remote limits.

It is to be hoped that the present indifferent communication with those districts of the province which lie removed from approach by water, may soon be improved. Hitherto not even the energetic efforts of elected superintendents have been able to overcome the practical difficulties in this respect imposed by the want of cheap labour, and hence the range of the settler in search of land is very limited, when compared with the noble expanse of country, amounting to near fifteen million acres, which exists, and which is nearly free from those mountain chains which detract so much from the apparent extent of some of the southern provinces. As most of the accessible land has been occupied, or bought up by speculators for the purpose of holding it (and this kind of speculation has been terribly overdone in Auckland), it follows that at present most Govern-

ment grants of land, however well they may sound on paper, are made in such situations as to render nugatory the apparent advantage to the receiver.

The people of Auckland are a busy, thriving, prosperous race, ready to turn their hands to commerce, agriculture, or home manufactures. The trade, both coasting and export, is large, and so steadily increasing, as, combined with their natural advantages, to promise a steady future of prosperity to the province and its capital, and render safe and remunerative the investment of money there, provided it be employed with ordinary judgment, and properly watched over. The population has reached about 19,000.

I must not omit, before leaving Auckland, to make mention of the celebrated "pensioner settlements" in its vicinity, founded by Sir George Grey. They were suggested by him to the Home Government as useful for the defence of the settlement, but were generally regarded in New Zealand as an ingenious device for developing the neighbourhood of the capital, by bringing thither an increase of population, and an accompanying expenditure defrayed out of the imperial revenue. In this sense they have been very successful, and each of the four villages formed by him (and which were placed about the narrow neck of land, by which all approach to Auckland from the south, save that by water, must be made) has become the nucleus of a place of importance. It is to be lamented, however, that the class of men thus introduced into the population appears to have been carelessly selected from among the lower ranks of the army, and has much tended to increase and confirm the fatal habit of intoxication, to which all new Anglo-Saxon colonies furnish a painful number of victims.

The society of Auckland cannot be highly spoken of. The class of settlers who originally came there, many of them from Sydney, with which place Auckland has always been intimately connected, were not in general men of such high education as those sent to the southern settlements by the New Zealand Company and Canterbury Association. Moreover, the place has been for a long time divided by fierce factions. These originated in the resistance of the former colonial authorities to the extraordinary pretensions of early land-claimants, who had made so-called purchases from the native chiefs, before the days of settled government. One of these modest individuals, by the way, asserted his right to a quarter of a million of acres, and declared himself most barbarously used because both governors and supreme courts have declined to recognise his title.

Proceeding in a southerly direction from Auckland we come to the province of New Plymouth, or as it is now universally called, according to the old native name, Taranaki, which is the smallest of the six original divisions of New Zealand, and occupies a strip of the western coast, extending from the boundary of Auckland to that of Wellington, and contains about three million acres of land. The settlement in question was founded in 1842 by a party of colonists from the neighbourhood of Plymouth, and still retains marks of its origin in the strong Devonshire accent of many of its inhabitants, and their strict adherence to clotted cream and other local luxuries of their native country. The town, or rather village, which is the seat of the provincial government, was laid out

originally on a scale suited to a city of some 50,000 inhabitants; but the ambitious desires of the projector have not been realised, and scarce one-hundredth part as many people occupy it, the whole population of the province being probably under 2,500. And yet this small number of settlers are found in the most lovely and fertile scene which the colony boasts. A rich and well-watered plain, fringed with noble forest, rises gradually from the sea into a group of green hills, which meet together at the base of the matchless Mount Egmont, *the mountain*, as the settlers emphatically call it; whose bright summit of snow, rising 9,000 feet high in peerless solitude, and contrasting with the rich colours beneath, forms as lovely an object as the world can show. The colonists of Taranaki, of whatever class, have a laudable pride in this great ornament of their province, and, in placing a new house, the first thing looked to in the site, is the having a good view of it.

The soil around the settlement is light and easily worked, and, where there is forest to be cleared, the great richness well repays the labour. The summers are less warm than those of Auckland, and the climate on the whole superior. The people, whom the advantages of such a soil and climate lead mostly to agriculture, are homely and friendly, and the secluded nature of the place, the reason for which will presently be referred to, makes them more like a portion of the rural population at home—only happily without the poverty of the latter—than those of any of the other settlements.

It may now be most reasonably asked, why has the province made so little progress, seeing that it is one of the oldest in the colony, and is blessed with such natural advantages? The reasons of its backwardness are two—and every settler knows them but too well. The first is the want of a harbour. There is not one decent one along the whole strip of coast which belongs to the province, and the trade of the town is carried on through the surf of an open roadstead, where vessels can never be certain of lying for twelve hours together, as the first sign of a westerly breeze is the signal for them to slip anchor, and escape from the danger of a lee-shore. The energy of the provincial government, which has been compelled to undertake the shipping and landing of all goods and passengers, has done all that is possible to overcome this difficulty, by providing most excellent boats and trained crews for the purpose. Notwithstanding these efforts, the landing and embarking at New Plymouth must always be most inconveniently dependent on the weather.

The other drawback to the development of the settlement is a still more serious one, and until lately it partook more of the character of an actual danger than of a mere inconvenience. The number of natives living close round its limits, considerable when the first settlers landed, has been largely augmented since the prevailing Christian influence of the missionaries caused the liberation of a great many of the former Maori inhabitants of Taranaki, who had been led away into captivity during a series of wars carried on against them by the tribes of the north, and by the return of others whom fear had driven away from the country, which they, like the white men, justly considered as the garden of New Zealand. The constant increase of the Europeans, and their urgent desire to acquire more territory than that originally sold to them, awakened suspicion in their Maori neigh-

bours, whilst their unarmed character, and the absence of any apparent protection by their Government, (for no troops were stationed here,) gave birth to a contempt for their inferior strength. Hence for many years the Europeans had to submit to petty insults, and sometimes to serious annoyances, without redress, and of late the native hostile feeling showed itself in strong opposition to any sale of land to the white man by any portion of the surrounding tribes. On this subject the Maories, however, were not unanimous, and the two parties broke into open warfare in 1855, and erected their forts close to the borders of the settlement, into which their armed parties frequently entered, committing depredations, and the more hostile one threatening destruction to all Englishmen. The very unpleasant nature of these circumstances had hitherto been kept, in colonial fashion, perfectly quiet, lest it should injure the fair fame of Taranaki, but it had now grown too dangerous to be endured, and the government at Auckland were earnestly supplicated for aid. In consequence of this request a body of 550 troops was despatched to the spot under an able officer, who averted all threatened evils without actual recourse to arms. An efficient garrison has been ever since kept up at Taranaki, and, the chief native leader of the opposition having been lately killed, it is hoped that all danger of any future disturbance has passed away. The confined limits of the Government land of the province are, however, an unpleasant memento of what has been, and a considerable objection to the settler.

Notwithstanding the two great disadvantages I have striven to put fairly before you, the charm of Taranaki is to me so great, that, if I were now in search of a colonial home, I should not fix upon any other part until I had revisited it, and judged for myself whether I could not be suited there.

Taranaki is, I must in justice add, the only province where the grants of land to military settlers are in situations accessible, and therefore likely to be available for any practical purpose within the present generation.

The province of Wellington, the next in order, occupies, as you may observe, the whole of the southern part of the Northern Island, and is computed to contain about 7,000,000 acres. It is here that we first meet with the continuous mountain chains which cover so large a part of New Zealand, and which, splendid as they are to the eye, the settler would often desire to exchange for something less romantic and more practical. The town which gives its name to the province was founded by the New Zealand Company just before the rival Government settlement of Auckland, and the energy displayed in hastening the emigrants to it was undoubtedly a main cause of the peaceful possession by the English of this fair colony, on which the French at that time were turning a longing eye. Time would fail were I to attempt to describe how ship-loads of emigrants, who had purchased town lands and country farms, were thrown on the narrow beach of Wellington, to discover too late that their town acre lay on some slope where no house could be raised, and the farm on some inaccessible mountain side which could neither yield pasture or crop. They had to come to the knowledge also of the fact that the splendid land-locked harbour of Port Nicholson, of which they had heard so much, lies in a funnel of mountains, which causes frequent and lasting storms of such severity as to cut off all communications between the vessels anchored off

the shore and the beach close by them; that the town itself was most badly placed, being eight miles off from the only tract of arable land within a day's journey,—the Hutt Valley, and crammed into a most inconvenient situation between the sea and steep hills, which have scarcely left road-way along the beach; that the larger valleys of the interior lie mostly at great distances, to be reached only by a rough coasting voyage; and that the entrance to Port Nicholson forms such a loop with the straits outside, that the wind which brings the ship from Australia or England, fiercely repels her attempt to enter the channel, and compels her to await in that tempestuous and narrow sea the change which, every few days, turns the blustering north-west to fierce south-east. All these discoveries they made and rued, as many a successive emigrant since that time has done; but they were a hearty set and worked bravely on, and, aided by systematic puffing on the part of the Company at home, they founded a prosperous and growing community, which is now strong enough to draw to it a steady increase by its own force of attraction. The Company did not confine its efforts to the exaltation of their own chief settlement, but having in vain tried to get the central government removed thither, by acting on the local authorities, they did all man could do to depreciate the rival colony of Auckland at home. For this purpose books were written and exhibitions opened, ostensibly by private individuals but in reality under the Company's agency, with the double object of praising Wellington and injuring Auckland. But it is sufficient to add, in respect of these proceedings, that the natural advantages of the latter settlement have ever kept it in advance, to the intense envy and disgust of its southern rival.

A new and terrible drawback has been added to those already pointed out, as belonging to Wellington. It is found that the immediate neighbourhood is subject to a recurrence of earthquakes, and is evidently near the centre of an alarming volcanic action. Twice already has the settlement been desolated by these convulsions; no building of brick or stone is now erected there, and the chimneys (only 8 per cent. of which escaped injury on the last occasion) are necessarily built outside the houses, and constructed in the upper part of iron pipe. Those only who know the colonies well, can conceive what pains have been taken to conceal these facts from the public at home; nor is this unnatural in men whose whole property is dependent for its future value on a regular stream of immigration.

Wellington cannot be said to be an agricultural country. The only farming land within reach of the town, the Hutt Valley, a rich strip of ground, but very subject to violent floods, is taken up, for it only contains a few square miles. There are, however, many fine tracts for pasture in the interior, and others on the large rivers, which can only be reached by the coast line. The more active of the old settlers have taken up all the most accessible of these, and the export of wool has become considerable.

The climate of the province of Wellington is usually fine and remarkably healthy, the air being more bracing than that of Auckland. That of the town is, from the peculiar local situation before referred to, so continually subject to boisterous winds as to make it somewhat disagreeable, especially to the softer sex.

The energy of the provincial authorities and the inhabitants has

triumphed so far over the disadvantages of the locality, as to bring in a considerable increase of population during latter years: there cannot be much less than 10,000 people in the province at present, even deducting the loss by the cutting off the new province of Hawke's Bay.

The most flourishing of the out settlements of Wellington is Wanganui (the English name here, as at Taranaki, has been abandoned for the native one), which is situated about 120 miles to the north, and on the western coast, on one of the noblest of the fine rivers before alluded to. The little town and its trade are prospering, and the land is so fertile, without having as yet reached extravagant prices, as to offer probably more inducement to the farming settler than any other of the offspring of Wellington. Wanganui is however open to the objection of being within the reach of the earthquakes, which have done considerable damage there.

Proceeding round the northern island to its eastern coast, the next in order is the new province of Hawke's Bay, formerly better known by the name of its chief settlement, the Ahuriri Valley. This was, as before-mentioned, made separate from and independent of Wellington a few months ago, and the new town of Napier, at the entrance of the Ahuriri river, created into its capital. The province contains near four million acres, being about one-third of the former contents of that of Wellington. The sheep-farms of the Ahuriri are celebrated for their excellence, and since they became thus known the trade and population, both very small five years since, have been rapidly increasing. As might be expected from its being an offshoot of Wellington, the necessary supplies were at first imported solely thence, but latterly the Auckland merchants have been exporting considerably by the coast to the new market, to which indeed they have naturally as ready an access as those of the former town. An important geographical feature in the province, as the later maps show, is, that part of the western boundary is that large stream the Manawatu, which promises to give a good communication from the back settlements to the west coast near Wanganui.

The chains of mountains lying around Wellington do not appear to extend far into Hawke's Bay, and there is very much available land yet open to enterprise and capital for sheep-farming.

The earthquakes have been very severely felt here, and constitute at present the only serious drawback to the prosperity of the province. The climate is reported to be very good, and, judging from analogy, there is no reason to doubt its continuing to maintain its reputation.

We have now to cross Cook's Straits, and proceed to a survey of Middle Island. Its whole north is occupied by the province of Nelson. The chief and only town of the same name was founded by the New Zealand Company not long after Wellington, and, like that elder offspring, was not suffered to languish for want of notice. It is prettily situated in a nook of the mountains which border the large deep bay called Wide Bay, and has a curious secure little harbour, easily approached and entered by small vessels, but not convenient for large ones. There is a narrow plain of good land running from it round the bottom of the bay, and which I beg you will not despise, for the mountains along most of the coast are not so generous, and often terminate abruptly in the sea.

All that has been said of the mountainous character of the Wellington

country applies with treble force to that of Nelson, where alpine ranges of gigantic aspect, rising in one part to 13,000 feet high, crowd thickly on each other. I have sailed round three-quarters of the coast of the colony at different times, and have not seen anything like a piece of level ground, save that bordering on Wide Bay in parts; in consequence of this want the harbour of Queen Charlotte's Sound—which a special map would show to be one of the finest in the world—is unused and unsettled to the present time. One large and fertile valley, the Wairau, which communicates by a circuitous road with Nelson, has been long known and occupied by sheep farmers. This district, which is now pretty well filled, seemed to be the only field for the superfluous energy of the province, until the recent gold discoveries. Of these last I need merely say, that, though rich enough to tempt a trial, they have proved not sufficiently so, to draw together or maintain such a population of diggers as to produce much influence on the colony. Gold, scattered in nearly a similar way, has been long discovered in the Auckland province, but the search has not been found to be regularly remunerative. The copper mines of both have also, as yet, proved failures.

The population of Nelson amounts to seven or eight thousand, but it is not increasing as fast as that of other provinces, if we except the temporary rush produced by the news of the diggings. The confined limits of the useful portion of the land will naturally tend to drive the more energetic spirits of the settlement into the neighbouring province of Canterbury, and the more especially as a way has been discovered by which flocks may be conveyed through the mountains into the latter.

The climate of Nelson is, perhaps, the finest in the world. The mountains lie round it so as to shelter it from the prevailing gales of the straits, instead of drawing down, as at Wellington, their concentrated force; and the vicinity of the snowy ranges tempers the warmest weather with an agreeable and healthy coolness. In this one respect Nelson may be allotted the palm of superiority to all other parts of New Zealand; but the want of available land constitutes so serious a drawback that it is certainly not a place to be recommended to any class of settlers except the special one of invalids.

I have said nothing of the nominal area of Nelson. The surveys are not sufficiently accurate to give it, and, were they so, the alpine character of the country would leave but a mere portion for the present purposes of man. No doubt more valleys will be discovered, opened, and used; but the mountains will last during our generations, and, though they may gradually be furrowed and washed down by storms for the use of succeeding ones, yet we cannot wait for this process, but must, in gazing around, feel inclined to say with the German savant who visited the province some time since, "My good friends, you am come here one five tausend year too soon."

Canterbury, as you may observe, occupies the whole of the central portion of the middle island. There can be but few, if any, here who do not know something of the history of its settlement in 1848, of the special High Church views which it was intended should there be developed unrestricted and full blown, of the high fixed price which all the land originally opened was to be sold at "to promote education and internal

improvement," and of the noble spirits and sanguine hearts of those who first sailed for the new Utopia. Alas for their hopes! alas for all who go to an infant colony unprepared with natural strength or artificial training to encounter the rude realities of a working life! Alas for the pious designs of the originators! The purely episcopal land has been entered upon and divided with the Church by the influx of members of a dozen different sects. The first gentlemen settlers have in too many instances disappeared, and their places are often filled by the rough labourer brought out in their train, who is now lord of the soil where he had landed with no capital beyond his brawny arms, to invest. The internal improvements are yet many of them deferred from year to year by the usual colonial difficulties—and yet the province flourishes bravely. Its climate is fine, and the summer heats tempered by the airs from the Nelson mountains to the north, or the cool south wind from the Antarctic ocean. The lands lying outside the original high-priced Canterbury block are sold (as nearly all are in the other provinces) at so moderate a rate as to tempt capital and energy from torrid Australia, as well as from over-populated England, to try the rising colony, and are so charming, that few who try, wish for any other home.

The lofty ranges which still occupy the western side of the island have here retreated from the eastern coast, and left vast plains where there is yet room for all comers. The familiar productions of the mother country were early introduced, and have invariably done well here, and the whole place has an aspect of improved comfort and stability, such as may be sought in vain in many of the much older colonies. Its commercial prosperity and population are undoubtedly increasing from year to year, and are strongly marked by the exports and imports, which are rapidly augmenting, and promise soon to surpass those of all the elder provinces, Auckland excepted.

The public treasury of this interesting settlement is at present in a happy state of plethora, and the authorities are taking serious steps towards the tunnelling through a most inconvenient hill which at present divides their capital of Christchurch from the excellent harbour of Lyttelton, now generally called Port Victoria. This improvement effected, there will be little left to be desired for the advancement of Canterbury.

Last, but not least, of the settlements of New Zealand, is that of Otago, founded in 1849 by members of the Free Kirk of Scotland. This noble province, very much of which is quite unexplored, contains probably more available land than any of the others. As in Canterbury, the western portion is of a mountainous character; the eastern generally level, and highly suitable for pastoral purposes. The port being very remote from the northern settlements, and the country more recently opened than the plains of Canterbury, the original settlers have been more fortunate in retaining their peculiar views uninterfered with, than those of the former; and extreme Presbyterianism and extreme Scotticism still flourish side by side round the little capital, which is, of course, named Dunedin. Not long since the superintendent refused to give his sanction to an ordinance of the Provincial Council for appointing an agent for forwarding emigrants from "Great Britain," objecting that the words used should be an emigration agent "for Scotland and other parts." A stream of new

settlers has now set in from the mother country, and from Australia, which promises soon to put an end to this miserable narrow-mindedness.

The country of Otago contains greater undeveloped resources, and a finer field for the inquirer for pasture lands, than any of the other provinces. Its enlarged prosperity is merely matter of time, and it is now so new as to offer very fine openings for capital invested in stock. The port is not so good as that of Canterbury, but large ships do lie there, and manage to accomplish all that they find necessary. The only other complaint I have heard made, respecting the province, is that of a want of wood in parts; but this matters little to the sheep farmer, who, in Australia, generally dispenses with any thing like a fence, and may do the same in New Zealand.

Nothing is now wanting in Otago but sufficient supplies of labour and capital, and these are steadily arriving. Of this fortunate province, and her fair neighbour Canterbury, it has been truly remarked, that in them may be found every advantage which Australia offers the settler, with a climate far superior.

It now only remains for me to offer briefly such remarks as may be likely to be practically useful on the subject of emigration to New Zealand.

And first, as to the classes of persons who may be likely to succeed there, or the contrary. Those who are living quietly in England, upon small regular incomes, which are enough for moderate wants, and who have no available capital, will do well to remain at home. Their expenses in the colony they will find quite as high, and they would there lose many of the comforts of civilisation with no corresponding advantage.

To those who have a little money to invest, with their own labour, and purpose trying sheep or cattle farming, it may be important to know that they should not attempt it, unless they can manage, on arriving in the colony, to have at least 2,000*l.* at their command. Less than this would but prove disappointing.

There are a considerable class of persons at home living up to or beyond pretty good incomes, but, were they out of the temptations of society, might save yearly a regular sum, and perhaps wish to do so, but have not sufficient resolution to carry out their desire. These would in a colonial life find two advantages: they might live just as they pleased as to their expenditure, and the surplus of their income could be invested, as it accrued, to very much greater advantage than in England.

Idle young men, who are looked upon as good-for-nothings at home, and are shipped off to the Colonies to get them out of the way, do in some cases reform, and struggle on to a decent subsistence; in the great majority, however, the temptation to drunkenness overcomes them, and they fall victims to it at an early age. No one of any class, who has the least tendency to the vice of intoxication in the mother country, can be safely trusted to settle in a colony.

There are at home many steady well-dispositioned youths, who have no great talent, or interest, wherewith to provide for themselves amid the crowd of strugglers for every means of subsistence. To such New Zealand affords many openings; but they should endeavour, before starting, to acquire a practical knowledge of surveying and of carpentry, two arts for

which the demand in new countries is incessant, and the knowledge of which is most valuable, even to those who do not get their living by them. This knowledge would avail much more than the rudiments of a profession, for, like all the other Colonies, New Zealand is already overstocked with mere professional men; the class of clerks, bookkeepers, and other writers and accountants, is, as every one here has probably heard, completely at a discount.

I have no where met with an adequate description of the miseries encountered by the mother of a very young family, whose father has dragged her into the bush to share a settler's life; no words can paint it truly. Servants in New Zealand will rarely go into the country at all, and few will stay in any house with a number of children. Ladies situated as above are therefore generally left alone to perform the most menial offices; between these and the care of infants, the health usually breaks down, the temper fails, the children grow up neglected, and the imprudent step induces a life-long misery, and frequently a premature decay and death. No narrowness of resources, or yearnings to be working for those you love, should tempt a family to emigrate, till the younger members are old enough to be nearly independent of a mother's care.

And now to speak of the mode of proceeding. A young man going out alone, and who is to receive some little capital from his friends, should not have power to touch it until he has been at least a twelvemonth in the settlement he chooses, and acquired a thorough knowledge of it.

No one, indeed, who intends making any investment, should think of doing so on his first arrival in a new country. Let him rather live in a quiet, economical, and observant way, for the first few months; the experience thus gained will richly repay him. The capitalist will find so much choice between the purchase of property, mortgages at rates quite unknown in the old country, public loans, and investments in farming, that he will do well to pause before he commits his means irrevocably to either. Mines worked with labour at colonial wages are generally failures, and I only mention them to recommend their being avoided.

It is a common mistake for persons with moderate means who are proceeding to the colonies, to invest a considerable part of what they have in the purchase of agricultural tools, ready-made houses, and the like. This should be particularly avoided, for two reasons. It is desirable to have as much money as possible available, when a short residence in the colony has rendered the new arrival *au fait* at what his real wants are, and what is likely to suit him,—a knowledge that cannot be by any means acquired at home. It is also very much better not to encumber yourself with a load of articles which must either tie you to a spot which may not be found such as you would like to fix your home in, or must be sold at a sacrifice if you desire to try some other locality. I have known a retired officer arrive in New Zealand with a load of useless purchases foisted on him by the outfitter as being indispensable for a bush life, the price of which would have gone far to settle him in a farm already cleared and built upon, the only way in which his health and habits would have let him have any prospect of succeeding.

I will not detain you by going into the hackneyed subject of the nuisances English servants are in a colony; but only say that no one should spend

money in taking those out with them who are not bound to them by a real tie of affection. No domestics are so troublesome in New Zealand as those who have just arrived from the mother country, and whose heads are turned by the sudden change of their relative position with that of their employers. No maid-servants can in general be persuaded to stay away from the settlement towns. The best chance of getting assistance for those who intend really trying the bush life, is to engage a respectable married couple, of country habits, and to pay them the full colonial wages from the very day of arrival.

I have already given a warning, and I would desire to repeat it most emphatically, to those who are seduced into the idea of emigration by so-called "grants of land to military settlers." As soon as a colony is past its infancy, such grants are thrown so far back into the more inaccessible parts, as to cease to be of any use, and to bear a merely nominal value. Taranaki is, as before noticed, the only province where I found they are really made of use by the individual receiving them.

The last recommendation I have to offer, I would most seriously strive to impress. It is simply that any married man who is bent on a New Zealand life should go out first, unencumbered by his family or property, free to move about, and see for himself whether his views for the future can be realised in the colony, and, if so, in what part. If they cannot, he will be thankful for making the discovery before any irretrievable step is taken. If they can, he will never repent the time occupied in deliberately making his choice of his future home. He will find this also a saving measure to his purse, as the expense of maintaining a family on first arrival till the home is fixed on is a very serious matter, compared to that of the maintenance of a single individual. I need hardly add, that no retired officer should surrender the whole of his income to settle himself in any colony, till his home be actually made there, and found to suit him.

In conclusion, it may be brought to your notice, as a summary of the observations now made on the different parts of New Zealand, that Auckland is to be recommended as a field for commercial enterprise and the investment of capital; Canterbury and Otago to all who desire to try a sheep or cattle farm on a large scale; the latter province, and that of Hawke's Bay, to such as, with smaller means, wish to begin the same life where the pressure of competition is least; and Taranaki to those who seek for the richest and most readily available land for agriculture, and the fairest spot for a home.

Friday, April 29th, 1859.

General SIR WILLIAM GOMM, K.C.B., in the Chair.

ON THE ADVANTAGE OF CULTIVATING THE NATURAL AND EXPERIMENTAL SCIENCES, AS PROMOTING THE SOCIAL COMFORT AND PRACTICAL UTILITY OF MILITARY MEN.

By Major-General PORTLOCK, Member of the Council of Military Education.

IN addressing an audience assembled in the lecture room of an Institution founded by the members of the Naval and Military Services on a subject not directly connected with warlike operations, either on land or on sea, I feel, especially at this critical period of our history, that it may be necessary to clear away from your minds some natural, or rather ordinary, prejudices; and to entreat you to adopt a more lofty principle than that which would require no more knowledge to be gained than is considered just sufficient for ordinary practical purposes, or as having a direct bearing either on the production of wealth or on the special objects of some particular profession. This rigid application of the *cui bono* test to mental operations has a tendency not merely to narrow the basis of preparatory education, but also to limit the extent and diminish the chances of future progress. No one can indeed over-estimate the ill consequences of so narrow a view of the objects of education, for who can foresee at what moment some branch of knowledge, little valued when acquired, may not prove to him an instrument of power, by which he may overcome a difficulty otherwise insurmountable or secure a result otherwise unattainable? The fable of the Mouse delivering the Lion may be indeed accepted as an illustration of the power which an intellect sharpened by study and stored with the facts of experience bestows even on the physically weak, enabling him to resist or to overcome, and in many cases to assist, the strong. Force of mind will, indeed, in most cases be more than a match for force of body, just as a small army will often baffle and even vanquish a much larger one, as was the case in the wars of Frederick the Great.

My object, however, is first to consider this subject under a different light, and to impress upon your attention a fact which, though generally admitted to be true, is too often forgotten, overlooked, or neglected in practice; namely, that mind and body together constitute the human being, and hence that the health of the mind is as necessary, as the health of the body for the preservation of the living man in a state of vigour and effectiveness. The old aphorism, "*mens sana in corpore sano*," is indeed equally true, whether interpreted as meaning that a healthy body is neces-

sary for the preservation of a healthy mind, or as meaning that a healthy mind, that is to say, a mind active and free from oppressive care, is necessary for the preservation of the body. This statement may at first sight appear to you speculative or metaphysical, but in practice it has been amply and frequently confirmed. So long as man is in motion, and the excitement of changing scene, of varying events, and of prospective danger continue to act upon him, the machine maintains its efficiency; but should this excitement cease, and passive difficulties, such as those of heat, cold, hunger, thirst, or the still more fearful ills of idleness and ennui, begin to surround him, the mind, wanting its wholesome and proper aliment, begins to prey upon the body; the body loses its tone, and as it gradually declines reacts upon the mind, which in its turn hastens the decay of the body, until at length that rest, which even sleep refuses to bestow, is attained in death. This necessity of attending both to the mind and to the body in training up the individual man is equally manifest, whether the object is to obtain a maximum of advantage from the efforts of the body politic, or of the body military; and the observation of Von Decker is truly philosophical when he states, that a "nation, having resolved on a war, cannot expect to realise great events, unless by concentrating upon the object in view all its energies—physical, moral, and *intellectual*, or, in other words, its whole vital force." This great principle has been ever kept in view by wise Commanders, whether on land or on sea; and, although the means adopted may vary with different men and in different nations, still the object is the same, namely, to keep up the *morale* of the men,—that expressive French word meaning a mental condition so strengthened as to resist the many causes of physical depression which are likely to assail both the sailor and the soldier in some period of their service. Marshal the Duke of Villars, so well known as one of the Generals opposed to Marlborough at the bloody battle of Malplaquet, at which he was severely wounded, when he returned to the army of Flanders in May, 1710, set to work as his first step to reanimate the drooping spirits of his men by exhibiting before them a cheerful and undismayed countenance; and then by a Ball he recalled once more the natural gaiety of a Frenchman's heart, no doubt with the conviction that once set to dance he would be equally ready to fight. This you may think was more suitable to Frenchmen than it would have been to Englishmen; but I think we shall see that similar expedients may be adopted with equal advantage even with Englishmen.

That such a mode of freeing the mind from corroding care does ever excite a smile in some is because few, if any, have hitherto ascribed to its true cause that peculiar influence which the graceful movements of the dance, the rapid motion of the hunt, the song of birds, the ripple of the running brook, the sighing of the wind amongst the branches of trees, the varied colours of flowers, or the green tint of a grassy bank, exercises upon the mind, and through it upon the body. To me the fact of such an influence being exercised appears sufficient to prove that there is a natural link of connection between man and all the other works of creation; and, as the pleasure derived from the contemplation of external objects can only be realised by the instrumentality of the mind, it is manifest that the less the mind is trained to observe, to think, and, I may say, to enjoy, the more the body must be deprived

of those springs of action and sources of happiness which are so eminently fitted to keep it in health and vigour. Many now present will doubtless remember how wisely our Arctic Voyagers sought for other means of repelling the chilling effects of intense cold, and of the unvaried dreariness of the scene around them, than those afforded by good food and clothing; and established for this purpose, on the bosom of the ice and amidst the surrounding snow, amateur theatricals. I have before me the amusing work entitled "Illustrated Arctic News," composed and published by the officers of the "Resolute," when in search of Sir John Franklin and under the command of Captain (now Admiral) Horatio Austin. If you look at the somewhat grotesque, but still amusing and exciting, accounts of the theatrical entertainments, exhibited on a stage of ice and before rough sailors wrapped in furs or other repellents of cold, and read the witty commentaries on passing scenes, you will readily perceive that such a mode of entertainment, by keeping them from dwelling upon surrounding difficulties, was one of the best expedients that could have been devised to keep up the spirits of men under very difficult circumstances, and to enable them to bear up against trials and privations under which, without some such stimulus, they must have sunk. You will all recollect that the same system was adopted with the same results before Sevastopol, where the French and the English had their theatres. Now, the act of preparing for a theatrical performance is an act of some mental labour—it requires those engaged in it to read and to commit much to memory; yet, that labour was cheerfully undertaken, and proved a source not only of enjoyment, but of mental and physical renovation.

I could pursue this subject further, but I will content myself at present by observing, as regards the soldier, that though much has unquestionably been done towards his intellectual and his moral improvement, and also towards his physical comfort, something more is required; namely, that more attention should be paid to his recreation—a necessity which has long since been admitted in respect to the poorer class of civilians. I think that the soldier requires his playground as much as the schoolboy; and I long to see the time when even school studies will be more directed to those subjects which encourage the boy, as well as the man, to wander in the country and admire its flowers, or to climb mountains and examine rocks; in fact, give them motives for taking that exercise which imparts health to the body and vigour to the mind.

Neither officers nor soldiers are always provided with means of healthy recreation. Those who hear me may perhaps remember, how dreary and wretched country quarters, cut off from all sources of amusement, have sometimes appeared; though perhaps that is not so much the case now-a-days, when railroads facilitate communication, and take at least the officer rapidly from the dull village to the gay town. Under such circumstances as the above, had a spirit of research, and the tastes created in early days for the natural sciences, been called into action, no place would have been found deficient in sources of amusement, and of amusement always conducive to health. In fact, the study of every branch of science must have a cheering influence, and, as an example of what may be done by military men, I will read to you a remark of Captain Martin De Brette, who is an eminent officer of the French artillery. He had commenced the construc-

tion of an instrument (which is a modification of that invented by Professor Wheatstone) for testing the velocity of moving bodies. Whether Captain De Brette arrived at the same idea independently I cannot say, but it is only natural to expect, that able men pursuing scientific researches should often stumble upon very nearly the same ideas; but his is an imperfect instrument compared with that of Professor Wheatstone. He says, "I was called to Algeria on duty; I was therefore obliged to attend to the immediate and pressing duties of my new station, and to reserve the continuation of my inquiries till I entered again upon the leisure of garrison duty." It is this leisure which I hope one of these days will be more occupied by military men, in researches and studies calculated to invigorate both their minds and bodies.

You will readily, I think, gather from what I have now said, that I myself consider the object of all education to be twofold; firstly, to give the student such an amount of some special knowledge as may be calculated to assist him in his future professional life, whatever it may be; and secondly, to afford him food for the exercise of his mental faculties. In our ordinary schools the great staple of education is, as you are aware, the classical languages. When this study is carried to a certain length, and matured at our colleges and universities, it unquestionably fulfils both the objects to which I have referred, so far as the persons for whom it is principally intended, namely, the members of the learned professions, as the Church and the Law, are concerned; but, if you stop short at an intermediate point, then it is impossible not to feel that enough has not been done to satisfy either the one or the other of those two objects.

I know perfectly well there are cases, and I can give you examples, where a large amount of classical knowledge has proved a source of great encouragement, and of great consolation under circumstances of great difficulty. I know one young gentleman, an officer of Artillery, who passed through the Royal Military Academy, Woolwich, at the time I was connected with it myself, and who, having received a good classical education, gained the prize for composition upon a particular theme—theme writing being then a mental exercise adopted at that establishment. I have since had the pleasure of reading some of his letters from India to his mother. Those letters breathe a spirit quite distinct from that of an uncultivated soldier. He appears to observe everything like a man of refined taste and of truly cultivated mind, and his descriptions, full of classical and scriptural allusions, read like the pages of a practised author. The spirit and feeling with which he writes, prove that the education which he had received enables him, in a distant region, to find sources of enjoyment in the objects around him, which would be totally unavailable to any one who had not received a similar education. I might indeed give you a still more forcible illustration, in the case of an individual who is respected by every military man, but whose modesty would not permit me to name him. I cannot conceive a more beautiful picture than that of such a person sitting down in one of the tents or huts before Sevastopol, surrounded by everything calculated to distract his attention; whilst wrapped in his cloak, to keep off the chill of a freezing temperature against which the gloomy tent, imperfectly warmed, if warmed at all, by artificial means was no

protection, and lighted only by a flickering candle—he pursues his literary recreation undisturbed by the din of war around him. How different, indeed, the circumstances to those under which a college student consumes the midnight oil! Polybius was probably never studied or read under such circumstances before, and all will admit that the gallant soldier was in this instance a true philosopher. These are examples of the results of sound early education even on the classical model; but they cannot be looked for in the great mass of persons, who, after many years passed at the schools, leave them with little more than the power of construing or translating the most simple Latin passage, and then only when they are allowed to take the exact passage, or at least to select the author they have read twenty times before.

I look upon mathematics not exactly in the same light as the classics. The lower branch of mathematics is essential to everybody; no one can, for instance, suppose that any military officer should be considered sufficiently educated who is unable to work out a common rule in arithmetic, or to keep a soldier's accounts: but the higher branches of mathematics require a degree of mental exertion, and a degree of mental power, that it would be out of reason to expect to find in all military men.

But when we leave these studies, and look to the natural sciences, the case is totally different. In them we have sciences which are at once fitted to exercise the highest faculties of the mind, and which at the same time tempt the student to the fields or to the mountains, promoting the health of the body whilst invigorating the mind. It will therefore be my object in the first place, before I come to the final part of my lecture, which will refer to the experimental sciences, to show you some of the advantages which military men may derive from the study of the natural sciences, both in a practical and in a social point of view, understanding by the term "social," that they promote and increase the happiness of a man, by setting him above any little difficulties or disagreeable circumstances which may surround him.

In the natural sciences at every step which you take, something new will present itself to be looked at, something to be wondered at, something to be admired. There are plenty of objects to be studied at home, and if you go to any other country, whether it be in Europe, the East Indies, Africa, or America, you will find everywhere something fresh—something which will excite your admiration, and kindle your enthusiasm. The Book of Nature is indeed inexhaustible, and wearies the less the more it is studied. I have had a diagram set before you to illustrate the deductions of geological science, and I refer to it first because it has many practical bearings.

A person totally unacquainted with the subject naturally looks upon the earth as having been always in the same condition as he now sees it; as a thing which was created in the form which it now exhibits. Such is the natural impression of a man of no scientific knowledge: for example, nothing is more common than the supposition, that of all stable bodies—bodies that are incapable of being moved, or upon whose undisturbed position you can rely with certainty—the earth is the most stable. The stability of the earth is, by every person unacquainted with science, supposed to be an established fact. Now to the scientific

man such an idea appears an error. First he finds, as you may see in the diagram, that instead of the earth being a great mass of matter, that came in the form in which we now see it from the hands of the Creator, it exhibits to us changes of various kinds, which have taken ages to accomplish. Those changes are various. We find that at every point of the earth's crust, where we can examine the strata, there has been more or less disturbance, by which they have been pushed out of their original position, the rocks which are designated stratified rocks occurring at very different elevations above the sea, some at 100, some at 200, some at 1,000 and more feet. If we were to look down through the ocean, supposing it so transparent that we could see to its bottom, and there observed deposits of mud, sand, or gravel under our feet, it would seem a natural thing; but when we observe the same description of deposits forced up to hundreds and sometimes thousands of feet above the level of the ocean, and we find that they teem with shells and other relics of various organic bodies which must have lived at the time of their deposition, then indeed we may marvel at the fact. Is it possible that any one who has had some little insight into these mysteries, as we may call them, has failed to take interest in their study wherever he had an opportunity to pursue it? Now these stratified rocks have been thrown up by the constant exertion of forces below. Those forces, whether gaseous or connected with electrical phenomena, or whatever may be their origin, act upon the melted matter under the crust of the earth and force it upwards. This melted matter pushes up all substances above it capable of being moved, and breaks and shatters those which offer greater resistance to the movement. The volcano represented on the diagram affords a natural and proper illustration of the phenomenon, because in volcanoes we see melted mineral matter forced up through the cracks or openings of the crater, and then poured out in a great stream, passing over and covering large tracts of country. The phenomena of many volcanoes are still exhibited before us, but we also see in the extinct volcanoes, such as those of the Vivarais and Auvergne in France, and those of other districts, proofs that, though there is no volcanic action now going forward in these countries, yet, from the nature of the rocks, and from various circumstances connected with them, volcanoes did there exist in full activity at some remote period, pouring out their lava exactly as Etna and Vesuvius do at the present moment. Then, if we carry our reasoning still further back, the same description of cause will account for the uplifting of various other intruded rocks—such as the greenstones, the granites, the syenites, and the porphyries—as all appear to have been pushed upwards, and to have dislocated at remote periods the earth's crust.

These facts are sufficient to show that any one walking over the earth's crust would look upon it with a very different eye when acquainted with geological science, even though his knowledge might be merely rudimentary, than when untrained to observe the facts, or reason upon the causes which have led to them. He will know that rocks have been uplifted by internal forces, that they have been worn and reduced to certain forms by the agency of water in the form of rains, of rivers, and of torrents; being deposited again in the form of sand, gravel, or mud;

then indurated, and again lifted up, to be once more shaped into the forms of hills and valleys. You can readily conceive that these effects must vary according to the nature of the rocks. If you are examining a country composed entirely of diluvial, or more properly detritic, deposits, or, speaking more generally, of stratified deposits distinctly composed of fragments of pre-existing rocks, such as sandstones, conglomerates, and so on, the wear produced by water will resemble that which you can now observe effected by rivers or by tides in narrow straits; but, if you look at those rocks which are supposed to have undergone a great amount of induration and metamorphism by proximity to the melted stony matter which has uplifted them, such as the mica slates and the gneiss rocks, which are very hard, the wear by water after upheaval is very slight, and it cannot be doubted that they have been fractured and dislocated in the act of uplifting. A defile or ravine in such rocks, as may be observed in mountain countries, exhibits steep sides, which cannot be ascribed solely to the action of water passing through it. In the one case the ravine is produced by the passage of water wearing through comparatively soft materials, whereas in the other it is the result of dislocation, the strata being uplifted and fractured so as to exhibit those steep jagged sides, which you meet with in the Alps and other mountain districts. Hence, if a military man, moving with troops in a country where the ravines had been produced by the gradual wearing action of water, were acquainted with the geology of the country, he would know that he could pass through a defile, because the sides not being inaccessible to his men, he might occupy, if necessary, the upper ground; but if, on the other hand, he found himself in a mountain pass through the harder rocks, he would know the almost impossibility of gaining the summit and dislodging his adversaries from it. We had indeed experience of this in our unfortunate contest with the Affghans, as you will remember the great advantage the natives took of being perched up on the rocks above our men, throwing down stones upon and destroying them, whilst we were reduced to a passive resistance, being unable to scale the precipices and dislodge them.

Further, I consider a knowledge of geology of great importance in the military sketching of a country, as the direction of the stratification must materially assist in enabling the topographer to determine the true form of the ground. I am aware that it is quite possible to sketch a country, as the objects on this table might be sketched, without having reference to what they really are; but to draw the plan of a country would be a very different task were the eye of the sketcher trained to look upon it as a result of geological causes. In looking at such a plan, and knowing the geological structure, he would, on observing certain features represented, be enabled to pronounce, "it is impossible that this can be a true representation, or the reverse." In this very case, therefore, a knowledge of geology serves a very important practical object. Geology has many other practical bearings, of utility to military men, in thus teaching them that certain things are possible, and certain other things not possible. If, for instance, we were in a country in which we desired to know whether it would be possible to find water, our geological knowledge of the order of stratification would enable us to predict that, after penetrating a certain portion of

porous strata, we should find a bed of clay retaining water, and hence that, by artesian boring, we should procure it; but if, on the other hand, we knew that there was nothing but a great mass of sand, and we were not aware that there was any clayey or other stratum capable of holding up the water, we should know that it would be useless, under such circumstances, to seek for it. In like manner, we should not look for water in granitic rocks. I recollect an instance myself at Fort Henry, in Upper Canada, where there was a great desire to sink a well in the fort. Resort was had to that old expedient, of which, perhaps, all have heard—the turning-stick; and the knowing man having held his stick in his hand, of course it turned round; and at the place to which it pointed it was assumed that water would be found. The authorities were so deeply impressed with the accuracy and certainty of this mode of discovering the presence of water, that orders were given to sink the well. This was in a solid mass of granite; the difficulties were great, and the expense enormous; but who could doubt the infallibity of the stick? Hence, not certainly wisely, though energetically, the attempt was persevered in till it became absolutely necessary to stop: an instance which will show you how important it is to have some little notion of the principles of such a science.

Botany is another science equally charming with geology. It equally takes us to the fields, and it contributes equal sources of enjoyment. We must all bear in mind that soldiers and sailors are generally the pioneers of men of science; they are the first persons who penetrate into new and remote countries, and therefore it is of the utmost importance that they should be prepared to notice the things before them, and to take advantage of their observation of them. The application of botany to practical objects is however not free from difficulties; for example, it requires a certain amount of caution before a conclusion can be formed that a country is likely to be fertile or the reverse. These difficulties are so many proofs to us of the great importance of multiplying observations, and therefore it is that I press upon you, as military men, the great desirableness of not overlooking even botany. Dr. Joseph Hooker says, "with regard to judging of the general character of a country from the aspect of its botany, it can hardly be done directly, though individual botanical traits may prove indications of the resources or capabilities of a country; and I think that military men should be especially cautioned against applying empirical rules to the selection of sites for camping, watering, wooding, or cantonments. I have noticed in my Indian journals how fallacious are appearances, how unhealthy are some of the most open, lovely, timbered, undulating grassy districts, where everything is charming to the eye and senses, and that some of the lowest, hottest swamps of Bengal are healthy districts to a very remarkable degree. I am credibly informed that some of the hill-tops of Penang (a small sea-girt island) are deadly unhealthy, whilst the jungle valleys are salubrious; and I fear we may safely conclude that, in the present state of science, we know just nothing at all of the *rationale* of the healthiness and unhealthiness of countries. Can any fact be more inexplicable than that agues, which prevail in so many swampy districts of the north temperate zone, are absolutely unknown in the south temperate zone? We cannot connect these, and a thousand other facts of the same nature, with either physical geography, geology, or vegetation. It is much

the same thing as regards the productiveness of a country. Twenty years ago any one would have been laughed to scorn who would have declared that tea could be successfully produced as well at the level of the sea, in the hot perennially damp tropical valleys of Assam, in latitude 27°, as in the excessively temperate districts of North-west India, in latitude 34°, at 2,000 to 3,000 feet above the sea; that wheat and oats should be staple crops in the plains of the Ganges; that the grape could be successfully grown and ripened annually at the level of the sea in Ceylon; that as good potatoes, carrots, and cabbages, &c. could be raised at Calcutta as in Europe generally; that rice should be grown on unirrigated hill-slopes at from 5,000 to 6,000 feet elevation in the forest-clad Himalayan ranges; or that coffee should thrive in the dry regions of Arabia and the hot humid forests of Ceylon. From all these cases, and innumerable others which might be cited, the conclusion is that there is nothing in the aspect of the vegetation of a country that would indicate its productiveness. When to this is added, that the most productive countries are often unhealthy for human habitation, or are otherwise unsuited to the operations of man's industry, it becomes evident that the whole subject is a very difficult, and indeed almost impracticable one, in the present state of science. On the other hand, there are often local indications of the productiveness of a country to be gathered from its vegetation in each locality; but this requires a special knowledge of the country and vegetation too. There are Australian judges of good land by certain Australian plants, and Canadians by a certain character of forest, in choosing new sites; but the Canadian's experience will not aid him in Australia, nor the Australian's in Canada, and no longer list of failures could be adduced than are to be found in the records of attempts to apply the local knowledge of one country to another.

"The productiveness of a country depends on its soil and climate, and not on its vegetation; the latter indicates neither soil nor climate, except in extreme cases, or in such gross generalities as that palms are prevalent in the Tropics, and mosses and saxifrages in the arctic zones? Who could have predicated that the sugar-cane would not yield good sugar in Ceylon, or that the *digitalis*, grown in the Himalayas, would prove inert, as is said to be the case? On the other hand, a little knowledge of botanical geography is often of immense use—but it must be sound and not superficial Though the vegetation of a country may not indicate its productiveness, a knowledge of its climate may indicate its suitability for certain crops, and the knowledge of the botany of a place may save an enormous expenditure. It is curious how little of our knowledge of the economic products of our foreign possessions we owe to our army and navy officers. How few of them have introduced a new wood for charcoal, a new timber for artillery waggons, or a foreign substitute for any of the materials used in their arms and other implements. How often do we see 'coals sent to Newcastle,' and under how many shapes, and all for want of a knowledge of common things! When I was in India the government were obliged to send troops and guns to Sikkim, at the foot of the Himalayas, and along with them went hundreds of loads of old bamboos for gun stages and similar purposes. Far better bamboos might have been cut at the very spot to which these were sent, in as many minutes as these took

weeks to transport, and of course at an enormously less expense. I shall never forget the shouts of laughter with which they were received by the European settlers and natives. When they arrived, the Hill Coolies absolutely refused to carry them up the mountains. Hundreds of other similar instances might be cited of loss of time and money occasioned by a want of common knowledge."

Dr. Hooker further says, and I am convinced it is a perfectly just observation, though perhaps some at the present day may not be disposed to admit it, "It is a curious fact that the majority of those military and naval men who have been distinguished for their love of natural history, have also been renowned in their profession; witness, Cook, King, Parry, Ross, Richardson, Franklin, in the navy; and you no doubt can match these names in the army, by such as Eyre, General Hardwicke, and Champion, a capital botanist, who was three times gazetted in the Crimea before he was shot at Inkerman." And he adds, which surprised me certainly, "Also the Duke of Malakhoff and sundry French marshals." This surprised me so much that I asked Dr. Hooker his authority for assuming that the Duke of Malakhoff was a naturalist, and more especially a botanist. He tells me his authority is his father, Sir William Jackson Hooker, who states that the Duke was a frequent visitor at Kew, and that he brought his wife there for her first visit after his marriage. "And, altogether," Dr. Hooker says, "he appeared to possess a scientific knowledge of plants; that is, he knew the scientific names of various plants, and in going through the collection he noticed that there were some deficiencies in the collection, which he afterwards had supplied from Algeria, through the intervention of Prince Napoleon." That was indeed a harmless visit, as no one could suppose that the Duke of Malakhoff went to the gardens for a hostile purpose; though, when he went to the Dorset coast to visit the Kimmeridge Coal Works, all the world supposed that it was to examine the capabilities of our coast for defence, or rather its defects as regards invasion. The truth of the matter was, that he went to examine the extensive works erected for the purpose of quarrying the Kimmeridge coal, and turning to profit the chemical products derived from it. I must say that the exhibition of such a trait in his character was most honourable to him, showing that he is not only an able warrior in the field but is equally distinguished as an intellectual man in time of peace. Marshal Vaillant, the late minister of war in France, is another distinguished example of the union of high military and high scientific qualities; he is a well known and active member of the Institute.

In Entomology, perhaps, it is not so possible to point out many practical applications; but no one can doubt that as a study it is full of interest. We have all been told by a sacred writer to study wisdom from the ant; and insects in general afford ample scope for our study and our improvement. Every country has its peculiar insects, as each has its peculiar plants. The competitive examinations have, I observe, already given to the Royal Engineers one able entomologist, who, whilst he performs his special duties with credit, finds healthy relaxation in his favorite science.

The combination of the organic with the inorganic element gives to geology that endless variety which sheds over it a charm that *fascinates* the imagination; whilst it has introduced that logical precision

which has raised geology to the rank of an exact science. I have already dwelt upon the remarkable physical phenomena of rocks, which may be studied every where; but, when we turn to the fossils associated with many rocks, a subject of study is opened out to us which is as deeply interesting as any of the various branches of the natural history of still living creatures. I have had a few models of fossil animals placed on the table before you, in the hope that they may excite the interest in your minds which they have done in mine. One of the drawings which I also exhibit represents a great and remarkable flying reptile, the pterodactyle, the largest that has yet been found, measuring, from one extremity of the expanded wing to the other no less than fourteen feet: what must have been the earth's condition when flying reptiles of such a size were flitting through the air, having vast jaws, armed with teeth similar to those of the icthyosaurus, the crocodile, and the alligator? The world, when inhabited by such animals, could have been very little fitted for the habitation of man. On this fact, indeed, may be founded one argument for concluding that man could not have existed contemporaneously with such animals. With all our appliances, and those too of modern origin, we might, by careful watching, manage to kill one of these immense animals in its flight, although its body would afford few spots a ball could penetrate; but in times anterior to the use of firearms, and when men had probably nothing better to defend themselves with than stone axes and flint-headed arrows, how helpless must they have been when opposed to such animals!—the sea swarming with the icthyosaurus and the plesiosaurus, and the air teeming with flying reptiles like the pterodactyle. In a science then of a character so eminently practical there is, as you see, an inexhaustible fund of material to warm the fancy and to exercise the judgment, and that without being denied the blessing of breathing the fresh air on the mountain summit.

On the other branch of my subject I must dwell more briefly. In the experimental sciences, chemistry is a very important one, both as a practical study and with regard to the great views it affords of the laws of nature. When I speak of it as a valuable study, in regard to expanding the mind, I have in view that it is by chemisty we know the extraordinary fact, that bodies unite with each other, not at random, but in definite and fixed proportions. Everybody knows what oxygen is, and also what hydrogen is. Now it is a law of the Creator, that, in order to form water, oxygen shall unite with hydrogen, not in any conceivable but in a definite proportion, that is to say, that eight parts by weight of oxygen shall unite with one of hydrogen to form water. Now this is a fact of extraordinary interest, in every point of view; and, although I had intended to illustrate it by a great many other examples, I will confine myself to one or two. You know that the common substance carbonic acid, is composed of one proportion, or equivalent as it is chemically called, of carbon united to two equivalents of oxygen; and, wherever you meet with carbonic acid, you may be sure that such is its constitution; for if one or more combining proportions were to unite with any other number of combining proportions of oxygen, the resulting combination would differ in all its properties from carbonic acid, and retain the same difference of character in all situations. This law of nature, by which bodies unite only in definite proportions, is as fixed and invariable as the law of gravity, and has as powerful an effect in securing the stability

of all created things; were it suddenly abrogated, all would be chaos again. As an illustration, let me state that oxalic acid, which, as you are aware, is a deadly poison, consists of precisely the same ingredieuts, only united in different proportions, namely, two of carbon to three of oxygen. How easy it might naturally appear to many, to change carbonic acid into oxalic acid, as one proportion more of each constituent would only be required; and yet oxalic acid, and oxalic acid only, is produced in certain plants by natural operations. The Oxalis acetosella is a plant well known to everybody, and yields abundance of oxalic acid; the Rumex and Lichens also produce it. The organic laws imposed upon these plants make them yield oxalic acid, and they cannot escape from their influence and form carbonic acid. Hundreds of other instances might be cited that would give you a high notion, merely in a speculative point of view, of the philosophy of chemistry, and an exalted idea of the wisdom and power of the Creator, who has laid his command on every living thing that it shall manufacture only those things which he has assigned to it to do. The oxalis produces oxalic acid, the sugar-cane sugar, and then again sugar from the cane is different from the sugar of grapes; nor, though the difference is small, could you by any contrivance extract cane sugar from the grape. Cane sugar consists of twelve proportions of carbon, ten of hydrogen, and ten of oxygen; and grape sugar, or glucose, of twelve of carbon, that is, the same proportion of carbon, eleven of hydrogen, and eleven of oxygen, to which are added three of water.

Similar facts might be cited in respect to gums, and many other organic products; but to call forth in your minds that admiration of the wonderful simplicity with which nature works out her results, however varied, I will only contrast the work of the Vine with that of the Acacia. The tissues of the vine afford three equivalents of water, and sugar is formed in the grape; but the tissues of the acacia do not cause water to combine, and gum only is produced, the other components being the same in both. Can anything more be necessary to convince you that the study of such a subject is quite as exalted in character, and quite as valuable in strengthening the mind, and even kindling the imagination, as the study either of languages or of any abstract science?

But there are practical subjects connected with chemistry which it would be wrong to pass over without some notice. You are aware that gunpowder is no modern invention, but the theory on which the proportions of its ingredients are determined is new. Nitre is a substance which was known of old, as were explosive compounds, but whether the properties of gunpowder were gradually deduced from such knowledge, or were discovered by accident, is a question which can hardly be said to be determined. At any rate, the true composition of it was at first very little understood, and in consequencs a great deal of material was wasted in its manufacture and use. Oxygen itself, you must bear in mind, was only first clearly made known in 1774; Hydrogen in 1766; Nitrogen or Azote about the same time; and Potassium was discovered by Sir Humphrey Davy in 1807. Therefore gunpowder, consisting of those primary elements, had been used for centuries before a correct theory of its composition had been established. Now, we know that, theoretically speaking, the mixture ought to consist of 11·9 of sulphur, 13·5 of charcoal, and 74·5 of nitre. These are the theoretical quantities which, after complete combustion,

would produce three equivalents of carbonic acid, one of nitrogen, and one of sulphuret of potassium, so that nothing but the solid sulphuret of potassium should remain.

The modern gunpowder of all nations approximates more or less to the above theoretical or definite compound; but we must not conclude, because an accurate compound has replaced a rude and uncertain one, that in the actual use of gunpowder the military men of early times were unskilled; far from it; there was almost as much skill and ingenuity then shown as we see exemplified now in that great military operation, mining. I will give you two instances, from history, in which mining performed a very prominent part in warfare. In 1672, in the defence of Philipsburg by the French, the siege lasted about four months. The besiegers, from the nature of the ground, had to construct several bridges over the canals which intersected it. The besieged adopted the expedient of floating mines, constructed so as to explode when they came in contact with the bridges. However, this was not a new operation even then, as similar contrivances had been adopted before. Hence, you see, there was no want of ingenuity in the application of the power of gunpowder. The second example is that of the celebrated attack of Luxembourg in 1683. The mining engineer, acting under Vauban, was Goulon. And we know of no modern instance where mines, both offensive and defensive, were carried to so great an extent, and performed so important a part in siege operations. Mines were followed up by counter-mines, mutually attacking and defeating each other, till at last the besiegers' mines were worked up sufficiently to make a breach, one hundred and sixty yards wide, by the simultaneous explosion of sixteen mines, and this was followed by an assault.

But a curious occurrence then took place, for before the French got into the breach they were attacked by a detachment, in flank, of cavalry; a panic ensued, and the French soldiers, who seemed on the point of being the victors, were for a time baffled in their design.

They were not, however, disconcerted; for Goulon immediately returned to his mines, developing them upon the whole front of attack, and had they been exploded a breach would have been formed far too large for successful resistance, except by an army. The besieged, seeing this, knew that any further attempt at defence would be madness, and capitulated. These two examples show us that in those days there was no want of mechanical ingenuity, but at the same time, in points of detail, there were many deficiencies. You must all recollect that the mode of exploding a mine was, until very recently, very clumsy. In the first place the connection with the mine was made by what was called a *saucisson*, or hose filled with gunpowder; this was put into a wooden trough, which extended to the place where it was intended to be fired; a little train of loose powder, covered with a piece of paper, was then laid down, one end in contact with the powder in the *saucisson*, and at the other a piece of match was inserted through the paper; or, when it was thought necessary to explode the mine instantaneously, the contrivance of the monkey was resorted to, which was a sort of little box placed over the powder, into which a piece of burning match was dropped by pulling back a valve or trap in the top of the box by a string extending to a safe distance from it. Notwithstanding the rudeness of this contrivance, as compared with those used at present, sixteen mines were exploded instantaneously in the siege I have

referred to, under the direction of Goulon, by the careful adjustment of the lengths of the *saucisson*, so that a place having been selected for igniting the powder, every branch from it to any one of the several charges should be equal in length, and thereby cause the powder to explode, practically, at precisely the same time. Miners were, indeed, then, as now, aware that the ignition of gunpowder is progressive, though to our senses it may appear instantaneous.

The simple method which I have described of taking this property into account, and causing the ignited powder to travel over the same distance before arriving at the charges to be exploded, was adopted by Vauban, and is even now pointed out in our military colleges, as it is always advisable to be prepared to replace, in a case of emergency, the more refined methods of modern times by the rude, yet ingenious contrivances of our ancestors.

Let me now explain what experimental science has done in improving the methods of exploding mines. Before I do this, however, I will call your attention to a different application of the same power which has been applied to the explosion of mines. Everybody knows that artillery science depends materially on the determination of the velocity of moving bodies, or in this case of projectiles. Formerly this was effected, indirectly, through the instrumentality of a Balistic pendulum, turning upon an axis a little in front of the gun to be fired. When the ball from the gun struck the pendulum it put it into vibration, and the extent of the vibration afforded the means of calculating the velocity of the ball. By this instrument the important results on which Hutton founded his reasonings and calculations were obtained; still it is but a rude contrivance. Now Professor Wheatstone, many years ago—as I can testify to having heard him explain it upwards of fifteen years ago, prepared an instrument for ascertaining the velocity of bodies in motion, such as shot and shells, by the agency of the voltaic battery. This instrument he also applied to measure the velocity of falling bodies. The falling body, the velocity gained by which is to be tested, is placed on a ring, or as we may call it forceps, the top of which is connected electrically with a voltaic battery. When the ring or catch is opened the ball falls, and the circuit being broken by the opening of the catch, an induced current is called into action by the attached induction coil, which at once sets in vibration a clock-like mechanism for recording the time of descent. When the ball impinges on the metal plate below, it descends, and by completing the circuit which had been broken, produces an induced current in the opposite direction, which stops the machinery, when by reading on the dial the number of revolutions the time becomes known.

[This experiment was exhibited several times, and the results when compared together were almost identical.]

This beautiful instrument is called the "Electro-magnetic Chronoscope," and can be applied to the determination of the velocity of projectiles in the following manner.

At definite distances in front of the gun, wire screens, made by carrying wire from side to side of a framework, are placed, and when the ends are connected with a voltaic battery, the circuit is complete. When the ball strikes the first screen, it breaks the wire, cuts off the circuit, and, by

means of the auxiliary coil, induces a voltaic current, which, as before, sets the machinery in motion for determining the velocity; and, again, when it strikes the second screen, the operation is repeated, but in an inverse direction, as the clock-work is stopped, and the time the ball took to pass from one screen to the other is determined, as before, by the number of revolutions marked on the dial.

I can hardly hope to make you clearly understand the ingenious manner in which Professor Wheatstone has secured uniformity of motion in the clock-work, by the use of an elastic musical spring, which is set in vibration by a hand-bellows, and shows by the musical tone it emits that it is so adjusted as to act on the teeth of the revolving wheel in such a manner as will ensure its regularity of motion. Everyone is aware of the intimate knowledge which Professor Wheatstone possesses of the theory of musical sounds; but this application of that knowledge to the regulation of mechanical motion may be said, when combined with the ingenuity of the whole apparatus, and its application to the determination of one of the most important data of gunnery, to be as striking an illustration as any I could have devised of the truth, I before enunciated, namely, that no one can tell the moment when the knowledge he has acquired of even a minute fact in science may become to him a most valuable auxiliary in securing a practical object.

By the kindness of Professor Wheatstone, I am also able to exhibit to you one of his military telegraphs, which is the more interesting as it enables me to explain to you an ingenious method of exploding gunpowder on the same principle, namely, by a purely magnetic apparatus.

I need not detail to you the various contrivances which have been founded on the known fact, that an electric current can and does call into action a magnetic one, and in this way modify or reverse the direction of the needle at will; but in this instrument advantage is taken of the reverse process, and an electric current is produced by the action of the magnetic. Hence the theory on which it depends is called Magneto-electricity and not Electro-magnetism.

The instrument now before you, inclosed in a box of about 1 ft. 6 in. square, contains a very small horseshoe magnet, the armature of which is kept in rotation by the hand and produces a rapid series of currents in opposite directions; the number of these currents is determined by pushing down one of the stoppers which appear arranged in a circle through openings in the case, their action being something like that of the keys of a piano.

Each stop or key is marked by a letter, and on pressing it down, the requisite number of currents is directed into the conducting wire which leads to the receiver at the other station, on the dial of which a magnetic needle points to the same letter. The instrument before you is capable of conveying a message 300 miles, which is as much as would generally be required for military purposes.

One of them is now constructing for Woolwich, another for Chatham, and a third is preparing for the Emperor Napoleon, who certainly has the merit of at once appreciating the value of scientific inquiry and of scientific attainments even in military men. Should it be his intention to take the field, as we presume it is, one of these telegraphs will in all probability accompany him.

The conducting wires are wound round reels attached to a light carriage, and are laid down as the carriage moves forward, whilst a pair of the instruments, also on a carriage, being left at the station of departure, another pair moves on with the army, so that at any moment a message may be sent to the rear or received in front, and this with the rapidity of lightning. Can any one doubt the effect upon military movements of orders thus conveyed at the most critical movement?

The magneto-electric principle exhibited in the instrument I have described is equally applicable to the explosion of gunpowder, thus avoiding the troublesome necessity of carrying about the acids, &c. as must be done in ordinary voltaic batteries. Experiments with that view have been made at Chatham and at Woolwich, and I expect that the machine will be shortly reported upon, and will come into immediate use. The machine used for firing mines is very little larger than this. It is formed of six small magnets arranged in the rays of a circle. The centre is occupied by a metallic plate which turns upon an axis, and at its edge there are attached pieces of metal which form the armatures of the magnet. As the plate is turned round, the armatures come in contact with, and then separate from, the magnets in succession, thus alternately inverting the magnetic circuit, when an induced electric current is on each change forced through the conducting wire, which, aided by the improved fuse lately introduced by Mr. Abel, is found efficient to explode a great number of charges almost instantaneously. The explosion is not absolutely instantaneous, as it may be assumed to be in the electric current from a common voltaic battery, as it is the result of a rapid succession of currents, and, therefore, of an equally rapid succession of discharges. Professor Wheatstone's experiments are sufficient to show that the rapidity of the electric current is equal to about 200,000 miles in a second, being about the velocity of light. French experiments, depending greatly upon the different conducting body which they use, give only half that velocity; still, even assuming the rate 100,000 miles, the additional space passed over by the successive currents in exploding the several charges would be so small as to render any difference in the time of their explosion by the magneto-voltaic apparatus inappreciable; but a well-trained ear can detect that the explosions by the present apparatus are not absolutely instantaneous. It is necessary to use for the explosion of numerous charges subsidiary wires running transversely from one of the conducting wires to the other, or wire proceeding to the earth. By this arrangement, should the electric current not be sufficient to force its way through all the subsidiary wires, it may, at least, effect the explosion of one charge, and that without injuring the main conducting wires, though the single subsidiary wire would, of course, be broken. But as the instrument is kept constantly revolving, and, of course, fresh electric currents and new discharges follow each other with a speed which baffles calculation, the explosion of all may be considered practically instantaneous.

I think these facts are sufficient to prove the immense advance which has been effected in this important branch of mining operations by the union of theoretical knowledge and experimental science. And if it be said by military men, as I know it is said by many, that they are unable to compete in scientific matters with such men as Wheatstone, I readily

admit that at present they are not able; but at the same time I must remark, that, in almost all continental armies, many of the most important discoveries in science have been made by military men: and of this fact I have given you an example in the invention by Captain De Brette of a form of chronoscope, the merit of which in Professor Wheatstone's opinion is considerable, although its inventor as a military man could only devote to scientific pursuits the leisure time which every military man possesses. It certainly is an advantage to all military men, particularly those in the corps of Artillery and Engineers, to possess a description of knowledge which awakens their faculties, and excites them to overcome difficulties, to avoid bungling arrangements, and to introduce improvements. It should, however, be an object in the education of military men in general (and not confined to the education of officers of particular branches of the Service, such as the artillery and engineers), to render them observing and intelligent men.

Let us remember that some of our greatest improvements in fortification, and some of our greatest improvements in many other military subjects, have been due to men in other arms of the Service. I say, indeed, is it not common sense to suppose that if every military officer had paid attention to some particular branch of science, and brought his mental powers to bear upon it, new improvements, and new inventions, would be frequently occurring to some one or other, without waiting till a great philosopher like Wheatstone, or a mechanician like Armstrong, had pointed out their advantage, and proved their absolute necessity?

I conclude, therefore, with a fervent hope that I have proved my statement, that the officer or soldier who has been instructed in any branch of the natural or experimental sciences carries with him an endless spring of enjoyment which no sensual pleasures or dissipation can afford, and at the same time his mind has been so invigorated, and so stored with facts of the widest practical application, that he will be armed with a new power, and be able to triumph over difficulties and dangers under which he would otherwise have been crushed. I here, therefore, conclude my Lecture, thanking you most warmly for the patience with which you have listened to me.

NOTE.—I am aware of the difficulty of making the subjects noticed in this Lecture fully intelligible without the aid of complex and costly illustrations; but at least I have said enough to render any reader cognisant of the results attained. I have pointed out one remarkable instance in which the perusal of Polybius in the original Greek afforded solace to one Crimean hero, my respected friend Major-Gen. Cameron, C.B., which he would not have obtained from simply reading a translation. The language itself was a source of enjoyment to the Scholar, in addition to that derived from the historical details. I ought to have added a Crimean proof that other officers found an equally powerful cordial in their pursuits of natural science, under what may indeed be called difficulties. My friend Mr. W. Baily, F.G.S., has described with much ability the fossils collected in the Crimea and placed in his hands by Capt. C. F. Cockburn, R.A., besides whom, I observe noticed in the list as having shared in the labour, and let me say the pleasure, of collecting them, Major Cooke, R.E.; Major Hudson, 39th Regt.; Dr. Sutherland, Sanitary Commission; Mr. Olver, Army Works Corps; Lieut.-Col. Munro; Dr. McPherson; Major Anderson, R.A.; Lieut.-Col. Lygon Cocks, Grenadier Guards. Had the number of collectors and observers been greater, the amount of happiness would have been greater also, and that without inducing any diminution of the military zeal or efficiency of the officers themselves.—J. E. P.

Friday, May 13th, 1859.

LIEUT.-COL. T. ST. LEGER ALCOCK, Vice-President, in the Chair.

GUN-LOCKS AND THEIR HISTORY.

By Mr. ROBERT T. PRITCHETT.

ALTHOUGH there are many to whom this subject would afford but little interest, yet all who have ever looked with pleasure on a gun must allow that no part is more worthy of our attention than the lock, or mode of ignition.

From the earliest periods up to the present, the lock has even given a distinctive name to the different arms, and in the present day they are alluded to as percussion guns, tube guns, or the flint, which is sometimes disrespectfully treated by the term "tinder box." The lock just now deserves our notice; the more so as likely to prove but a minor characteristic before the all-engrossing topic of muzzle-loader, or breach-loader. My chief endeavour will be to bring before you authentic specimens; I shall also endeavour to show when the different systems were used in the British army, and throughout to trace the various links that exist, particularly when, from want of confidence in a new system, the old one has been retained and used in the same lock.

We have four distinct systems, which may be thus described:—

Match-lock,	or ignition by	simple application.
Wheel-lock,	„	friction.
Flint-lock,	„	scintillation.
Percussion,	„	detonation.

These have all in their turn been used in our army in their simple forms, as described in the following table, the compounds having been made use of only for sporting purposes and "armes de luxe."

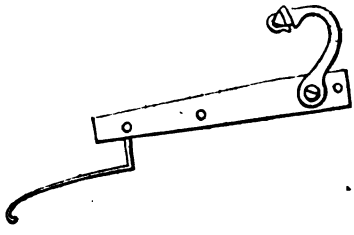
DESCRIPTION OF LOCKS USED IN THE BRITISH ARMY.

Reign.	A.D.	DATES OF LOCKS. Musket.	Carbine.	Pistol.
Edward IV.	1461	Hand Gonnes introduced into England.		
Henry VII.	1485	Match	—	
Henry VIII.	1509	Match	—	Wheel
Edward VI.	1547	Match	—	Wheel
Mary	1553	Match	—	Wheel
Elizabeth	1558	Match	Wheel	Wheel
James I.	1603	Match	Wheel	Wheel
Charles I.	1625	Match	Snaphaunce	Wheel
Charles II.	1660	Match	Snaphaunce	Wheel
James II.	1685	Match	Flint	
William III.	1689	Match	Flint	
Anne	1702	Flint	Flint	Flint
George I.	1714	Flint	Flint	Flint
George II.	1727	Flint	Flint	Flint
George III.	1760	Flint	Flint	Flint
George IV.	1820	Flint	Flint	Flint
William IV.	1830	Flint	Flint	Flint
Victoria	1837	Percussion	Percussion	Percussion

I need hardly mention here that the first hand "gonnes" had no locks, but were fired as hand cannons, and only at the latter end of Henry VI.'s reign had they the addition of the side touch-hole, pan, and cover.

The MATCH-LOCK was long-lived in the service, from 1485, when Henry VII. first armed half his yeomen of the guard with them, to William III. in 1689. In Mary's reign it was left to the people to find themselves guns or bows as they preferred.

The first form of match-lock was very unsophisticated, as seen in some old specimens of about the time of Elizabeth or Henry VIII. Two very fine ones are now in the Tower, which were presented by Lord De Lisle from Penshurst.



In a work called "England's Training for a Private Soldier," by Davies, 1619, page 121, Grose, vol. ii., we find, that the "match be carried between the fingers." In Captain Cruso's work, in 1632, the dragoon is directed to carry "the match burning, and the bridle in the left hand;" and in Rushworth we learn that the musketeers, when surrendering at Reading, in 1644, were "to march out with the match lighted at both ends, and their bullets in their mouths." Later again, in 1670, General Monk still thinks match-locks so important as to recommend (see page 132), "that the governor of a fortress be careful to sow at a fit time of year a competent quantity of hempseed for the making of match." One peculiar form of match-lock, bearing the date 1562, is well worth our notice; I have therefore made a sketch of it, as being the first form of relieving the cock with a spring with which I am acquainted. (See plate, fig. 1.*)

In this early instance the serpentine is drawn back to full cock, and to fire the gun, the match, as soon as the cock is relieved, is dashed down into the pan; there is no doubt, however, that, instead of igniting the priming, it frequently pushed the powder out without igniting it, and extinguished the match as well. There is a marked difference between the Eastern and European match-locks; in the former the match comes down towards the muzzle, in the latter towards the butt. The match-lock, with all its simplicity, gave considerable trouble in its use, as the following words of command will show, thus:

* It is curious to observe that matchlocks from Borneo and Java have the same arrangement of spring.—R. T. P.

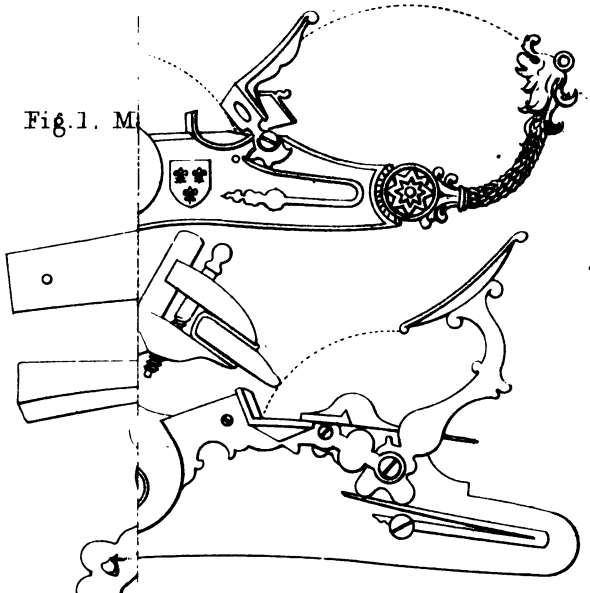


Fig. 1. M

Fig. 5. Snaphaunce

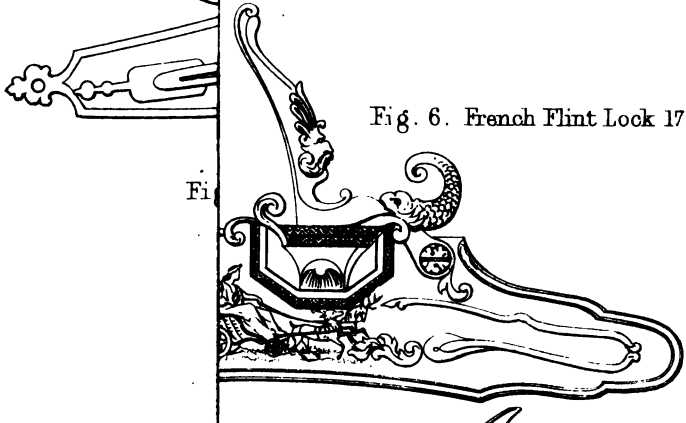


Fig. 6. French Flint Lock 1705.

Fi

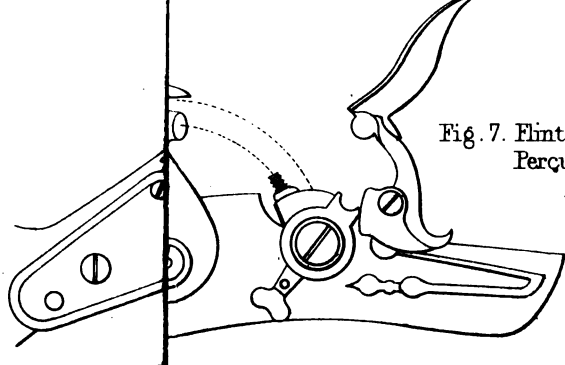


Fig. 7. Flint and Percussion Lock 1821

J.R.Jobbins

Words of Command for				
Match, 1630.	Wheel, 1632.	Snaphaunce, 1632.	Flint, 1745.	Percussion, 1853.
Take forth your match. Blow off your coal. Cock your match. Try your match. Guard, blow, and open your pan. Give fire. Uncock your match. Return your match. Clear your pan. Prime your pan. Shut your pan. Cast off your loose powder. Blow off your loose powder. Draw out your match.	Span your pistol. Prime your pistol. Shut your pan. Pull down your cock.	Bend your cock. Guard your cock. Prime your hammer. Fire your cock.	Half cock your firelock. Handle your primer. Prime, 1. Prime, 2. Shut your pan. Cock your firelock.	Half cock. Two, i.e. cap. Ready, i.e. full cock.

The second word of command must have been rather inconvenient to any one in the immediate neighbourhood. A cigar ash is dangerous to the eye; but 100 musketeers, all "blowing their coal," must have been frightful for any one to leeward. The match, when lighted, was very objectionable, as being likely to betray the bearer; to avoid this, the match was carried in a pewter case with holes [o o o o], and, to avoid the shot of the enemy, the infantry of the period were instructed to "fire going, and never standing;"—so advises Mr. William Garrard in 1587. The last guns of this sort used in the army are ably represented in many museums. There is a very good specimen of the time of William III. in the valuable collection of this Institution.

WHEEL-LOCKS were used as early as 1509, in the reign of Henry VIII. and were in origin Italian, as the Duke of Tuscany had a very splendid and elaborately-worked pair of pistols, dated 1530; and Benvenuto Cellini, about 1523, speaking of his gun and lock, leads us to suppose it to have been a wheel-lock.

The German reiters next attract our attention, by having, in 1545, wheel-lock pistols. In Mary's reign, in 1553, wheel-lock pistols were used for our cavalry; but I am not aware of any instance in which our soldiers had muskets on this principle. In 1558 Collado, in "A Treatise of Artillerie," published in Venice, mentions that they were in use before his time, and we find them continued in our cavalry until snaphaunces were gradually introduced in Charles I.'s reign. In France they were used until 1680; and in Germany sporting rifles were made on this principle until the end of the last century. The action of wheel-locks cannot be better described than by the following instruction for "Cavalrie" of the period:—"Span your pistol," which is, to turn the wheel with a spanner until it catches or stops. Then to prime, "Draw over the pan-cover," "Pull down the cock;" the pyrites resting upon the wheel, which comes through the pan. Directly the trigger is pulled the wheel flies round, and, drawing sparks from the pyrites, ignites the priming, the same action as "scissors to grind," but reversed in the wheel-lock. In the former the steel revolves, in the latter the steel is stationary. A very beautiful specimen of this work, of the time of Louis XIII. shows how art was encouraged in the manufacture of arms about this period, and to what a great extent it was carried; and only a short time since I saw a wheel-lock, equally beautiful, dated 1590, which had been altered from wheel-lock to match. In 1639 Ward speaks in praise of these locks in the following words:—"That they are not likely to get out of kilter, and will endure spanned twenty-four hours together without hurt." In Germany, about the year 1600, they were rather fond of making their locks with a huge mechanism outside, cumbersome in the extreme, and the spring sadly exposed, as shown in one of my specimens, which was in the Bernal Collection. (See plate, fig. 3.) Some cases are found where two cocks were used to one lock, in case the first missed; in others, again, we find the lock as shown in plate, fig. 2, where the match is retained, lest the wheel should ever fail: these date about 1590.

The term tricker-lock, about the time of Charles I. in 1633, is particularly mentioned in the gunmakers' rate. It means this—a hair-trigger, as now known to us.

We now arrive at the FLINT-LOCK, the lock of that gun, with which our great battles have been fought, with which Marlborough and Wellington gained their great victories, the days of which, added the names of Blenheim, Ramillies, Malplaquet, Peninsula, Assaye, and Waterloo, to the laurels of this country. Flint and steel (as connected with gun-locks) were known for a hundred years before they were adopted in the Service. This may seem a remarkable fact; but in the "Norfolk Archæologia,"* a blacksmith is mentioned as fitting a snaphaunce to a stock in 1588. Now the snaphaunce (see plate, fig. 5,) is really a flint-lock, although we do not accept it as such until the bottom of the hammer covers the pan. The earliest specimen bearing a date is a gun in the possession of the War Department, having the year 1614 on the lock and barrel. This belonged to Prince Charles. The stock is inlaid with silver thistles and Scottish designs, the barrel shows symptoms of being inlaid with gold, the whole forming a good historical relic. A notice of it was read last Friday at the meeting of the Archæological Society. In 1632 (time of Charles I.) snaphaunce carbines were the cavalry weapon. That period is to be particularly remembered as one at which match-lock muskets, wheel-lock pistols, and snaphaunce carbines, were all used at the same time in army.

In 1677, the Earl of Orrery gives five reasons why fire-locks were superior to match. "1st, more ready, the match being more roundabout; besides that, if not fired as soon as the match be blown, you must a second time blow your match, or the ashes it gathers hinders it from firing. 2nd, the match is very dangerous, either when bandeliers are used, or when soldiers run hastily in fight to the bridge barrel to refit their bandeliers. I have often seen instances thereof. 3rd, matches are seen at night. 4th, in rain, the pan being open for awhile, the rain often deads the powder and the match too, and in wind blows away the powder before the match can touch the pan, or else blows sparks into the pan, and fires the piece before the soldier is ready, who either thereby loses his shot, or wounds or kills some one before him, whereas the fire-lock [the term fire-lock is now given to the flint-lock] is so sudden, that what makes the cock fall upon the hammer strikes the fire and opens the pan at once. 5th, the store of match for an army adds so much to the baggage, and it is liable to get spoiled by the weather." In 1682, Charles II. (see Abridgement of the English Military Discipline, by his Majesty's command), the musketeer has a match-lock musket, the dragoon a flint-lock musket. In 1690 the musketeer has a match-lock, the grenadier a fire-lock. In 1685, at the coronation of James II., the guards are described by Sandford, in his elaborate description of the proceedings, as having "snaphaunce musquets."

The specimen in the Museum, bearing the initials J. R., shows that the reign of James II. may fairly be considered as the commencement of adopted flints, connected with which system is the doglock catch at the back of the cock. The reign of William and Mary, in 1690, brings us to the time when the last match-lock musket is made; and the battle of Steinkerque gives rise to a remarkable lock known as the *Vauban* lock,

* Norfolk Archæologia, p. 16, "1588 A.D. Payde to Henry Radoo, smythe, for making one of the old pistols with a new snaphaunce and new stock at Norwich."

and adopted in the French service. The drawing (see plate, fig. 4) I have taken from St. Remy, a most valuable authority for his period, about the year 1702. In this work the lock is described as the fusil-musket lock, because the flint was first applied to fusils; it was afterwards applied to the musket. In the Musée d'Artillerie at Paris, they describe the lock thus: "Fusil mousquet de Vauban qui au mécanisme ordinaire de ..... a batterie reunit le serpentin pour la mèche. A la bataille de Steinkerque (1692) les François jetèrent spontanément leurs mousquets, pour se servir des fusils pris aux ennemis. Ce fut alors que Vauban imagina son fusil mousquet, dans lequel la mèche sert au defaut de la batterie." The flint had not gained much ground in France at this period, although in the Spanish army it had been long used and known as the Platine à Miquelet. I may mention that a photograph of the Vauban lock has been kindly sent to me by the Minister of War in Paris,—an attention which I esteem highly. Without paying too much attention to the affairs of our Gallic neighbours, I may mention that from 1693 to 1714, a series of experiments with flint-locks was being carried on in France. In 1703 many flint-locks were in service, and the exquisite specimen dated 1705, made from designs by La Collombe, (see plate, fig. 6,) in my own possession, shows that in Paris they were no mean proficients in flint-locks; yet no model was adopted in the French service until 1714. From that time the French Government has made a complete series of model arms and their transformations up to the present date. In Queen Anne's reign a change took place in flint-locks so as to strengthen their form of construction; it was to carry the pan further through, so that the hammer-pin might be better supported. From this time up to 1837 no change took place. About 1772 Thomas Wright and C. Byrne produced a flint-lock which was self-priming, and self-hammer-closed; the patent can be seen by referring to No. 1,003 in the Collections of Patents on Locks. Cock-and-hen locks are alluded to in the patent Nov. 28th, A.D. 1799. Flint-locks are mentioned as being made so that the flint, by the operation of cocking, presents a different angle to the hen or hammer every time the piece is fired.

The very name of PERCUSSION seems so identified with our own day, that in fact it is almost too well known to require explanation. Cock your gun, cap, and fire, explains all; a few words as to the origin of the principle are, however, desirable. For its invention, like that of gunpowder, we are indebted to an ecclesiastic, viz. to Schwartz, the monk, for the latter, and to the Rev. A. J. Forsyth for the former. In 1807 Forsyth took out a patent to explode the charge by a grain of detonating powder. In 1816 Joseph Manton took out a patent for tube guns, which are still used; and in 1821 Samson Davis took out another for using the same lock, either on the percussion principle or with gunpowder, without changing the cock or hammer. The original of this patent may be seen in the collection in the Museum, and I regret that, as a left-hand lock is there, I have not been able to obtain a right-hand one as a fellow, in order to complete the pair.*

It was not until 1837 that the percussion principle assumed such a form as to be worthy of adoption in Her Majesty's Service. At first some

* A right-hand lock has since been placed in the Collection. (See plate, fig. 7.)

special arms were got up for the Foot Guards, with back-action locks, at the same time that some old arms were altered from flint to percussion. These being found satisfactory were continued in use for some time. A back-action carbine, known as the Victoria Carbine, the same as that now carried by the Horse Guards, was also adopted at that time. But, although the percussion principle was adopted in certain corps, and in the Brunswick Rifle for the Rifle Brigade, yet not until 1842 was a percussion model decided upon for the Army, or rather for the Line. This arm had not a back but a bar action. This remained the weapon of the Line and East India Company's Army until 1853. One great defect stamped the Line lock of 1842, viz. the shortness of the mainspring, which produced a very cramped action. There was also the radical fault of a hook-mainspring instead of a swivel. When the wheel-lock fell into disuse, the swivel that used to connect the mainspring with the tumbler was forgotten and ignored. So great is the difference of action between a swivel and hook-mainspring, that the former may be put together dry, and it will work easily and smoothly, whilst the hook-mainspring, unless put together with oil, will immediately grind; and so in fact it will always, unless kept constantly lubricated.

We have now reached a period when the experience of centuries has produced a satisfactory result in the lock of 1853, the pattern lock of our Service, which in simplicity deserves our praise, and in production our wonder. It will be superfluous to take up your time in detailing the processes of manufacture. I will only draw your attention to that most interesting collection in the Enfield rifle room in this Institution, where you may trace the gradual production of the different limbs and pieces from the raw material up to the highly-finished and perfect lock. The stages of fabrication, though numerous, are very interesting and very instructive.

Friday, May 20th, 1859.

Colonel the Hon. JAMES LINDSAY in the Chair.

ON ROTATORY MOTION APPLIED TO OBTAIN STABILITY FOR ASTRONOMICAL OBSERVATIONS AT SEA.

By the Rev. BADEN POWELL, M.A. F.R.S., &c. Savilian Professor of Geometry in the University of Oxford.

ABSTRACT.

THE subject of rotatory motion is one of large extent when considered in reference to the principles of theoretical mechanics, and is connected with some of the most abstruse theories of analytical dynamics. Yet some of its simpler properties, laws, and results admit of direct experimental demonstration, and such elementary ideas of the subject as can be thus communicated are fortunately quite sufficient for the full comprehension and elucidation of some of the most important and valuable practical applications of the principle.

The object of the present Lecture is restricted to the explanation of one or two of such applications which are interesting, and promise to be of considerable practical importance to nautical astronomy in supplying the means for attaining that much-desired object, a stable support applicable to the purposes of astronomical observations on board ship.

In order to render the description of such inventions intelligible, it will be necessary first to advert to one or two theoretical points involved in the nature of the constructions.

The principle of "the composition of rotatory motion" is one of fundamental importance for the explanation of nearly all phenomena of the kind we are considering. It is susceptible of very simple and elementary illustration. If we merely consider the familiar case of composition of rectilinear motions, a body moving by a force which would alone carry it through a given space in a given time, acted upon also by another force, which in the same time alone would carry it through a space in a direction transverse to the former, will, under both, in the same time, describe a space which is the diagonal of the parallelogram of which the two former are the sides.

In like manner, if a body be rotating about an axis, a point in its circumference describes in a small interval of time a small arc, which may be regarded as rectilinear; if a force act on it which in the same time would cause it to rotate in another direction, or to describe a small arc transverse to the first direction, it will, under both, describe the diagonal of the small parallelogram.

In order that the small arc of the circumference may take this new position, it is merely necessary that the axis should take a new direction,

or the plane of rotation of the whole body should shift into a new position, without any change in its inclination to a given fixed plane.

This is the actual case of the earth's rotation as affected by the attractive force of the sun and moon tending to pull down the protuberant equatoreal matter of the terrestrial spheroid into the fixed plane of the ecliptic or earth's orbit, giving rise to that slow shifting of the direction of the earth's axis, which carries with it the equinoctial points or intersections of the equator with the ecliptic, without the smallest change in the inclination of the one to the other, and which is the explanation of the well-known phenomenon, the precession of equinoxes.

Hence, in the general case of compounded rotatory motions the resulting effect of this kind is called a "precessional motion." Of this we have many practical instances, especially in the constructions about to be described.

It is also necessary to explain the term "axes of rotation." If any body of whatever form be forcibly struck, it will acquire, besides the general motion of translation, a rotatory motion, unless the stroke happen to be directed exactly through its centre of gravity. There is always some one line passing through it, about which it will for the moment be rotating as an axis; but in general this direction will be perpetually changing, until the rotation at length becomes permanently settled about some line related to the figure of the whole mass, which is termed one of its "principal axes." It can be demonstrated that every body has at least three such axes, and in regular figures their position can be determined.

The principle termed "the constancy of the plane of rotation" is evinced in this, that a heavy body rotating about its principal axis shows a powerful tendency to continue its rotation about that axis, in the plane in which it was originally impressed, so much so as to offer a very forcible resistance to any attempt to give it while rotating any inclination out of that plane. This is most conspicuously displayed when the rotating body is mounted on gymbals, so as to be free to turn in any direction.

To occasion this tendency there is, besides the mere inertia, the law of permanent rotation about a principal axis, and the composition of rotations, from which any small tendency to change of direction would not show itself directly, being compounded with the original rotatory force.

These, and a variety of other analogous and related phenomena, are conveniently exhibited by the small apparatus now generally known under the name of the "Gyroscope," originally devised by Bohnenberger, and described by him in 1816, and since largely improved upon by various other mechanists, until it has received its most complete form from the improvements of Professor Wheatstone, in 1854. While for more specific purposes it has received a different construction in the beautiful adaptation of M. Foucault, in 1854: the idea of which was, however, suggested by Mr. Sang of Edinburgh so long ago as 1836.

These preliminary considerations will prepare the way for the elucidation of that remarkable practical application of the principle of rotatory stability which is the specific object of the present Lecture, the means of affording a stable platform for astronomical observations on board ship, exempt from the motion of the vessel.

It is true that for some of the most ordinary, and at the same time most important, operations of nautical astronomy, this stability, owing to the happy invention of Hadley, is not needed.

But there are other classes of observations which it is highly desirable, if not necessary, to make at sea, for which this principle of stability is absolutely essential. Nay, even for the ordinary purpose of measuring altitudes, there are continually occurring cases when the sea-horizon cannot be discerned, while the sun or star is clearly seen above. Hence some means of obtaining an artificial horizontal level becomes of great importance, but unattainable by those means so easily practised on land, by reason of the motion of the ship. Hence, with only this limited, but important, object in view, various plans have been devised; and of these one of the most hopeful was derived from the principle of rotatory stability. The commonest observation showed how easily such stability (in a general sense) was acquired by the mere spinning of a top: and, though many other considerations were really involved, not at first fully apprehended, yet the general idea seems to have presented itself more than a century ago to the inventive mind of Mr. Serson; at least, as far as seems at present known, this is the earliest attempt of the kind on record. The invention consisted essentially in a circular plane reflector through the centre of which an axis passed, the lower part of which terminated in a steel point resting in a hemispherical cup of agate: on the upper a string could be wound by which it was spun; as the support moved with the ship the point shifted its position in the cup, always tending to the lowest point, and thus a nearly horizontal rotation was attained. A brass rim round the reflector descended so low as to bring the centre of gravity of the whole nearly into coincidence with the point of support. If this coincidence had been exact, the instrument would have been more perfect, theoretically, than some since made.

An account of the instrument will be found in Brewster's Cyclopædia, art. Sextant, with a figure. A shorter account is given in Rees's Cyclopædia, art. Horizontal Speculum.

The inventor went on board the Victory in 1744 to try the plan. In this ship (of 110 guns and 1100 men) he was unfortunately lost, when it was totally wrecked by striking on a reef off Alderney in the night.

In the Phil. Trans. 1751–2, there is a paper by Mr. James Short, who speaks of the invention as well known. He also states that this top when spun took "the true horizontal plane," and was not disturbed by any motion or inclination given to the box in which it is placed; and thus "may be proper to be used aboard ship" for taking altitudes.

Mr. Short's object was to try whether (as had been suggested) the air had any share in causing this horizontality. He therefore tried spinning it *in vacuo*; and observed that, while in air it kept up 36 minutes, *in vacuo* it continued spinning for 2 hours 16 minutes, "preserving a perfect horizontality for three quarters of an hour."

Owing to whatever cause, however, the invention of Serson seems to have fallen not only into disuse but into oblivion. Some plans on exactly the same principle have been proposed more recently, apparently without any knowledge on the part of their inventors of Serson's priority. But it does not appear that any material improvement in the performance has been attained.

Another invention, that of Mr. Weir, some years later, differed from Serson's only in making the centre of gravity fall below the point of support. This, as we shall presently see, was an error.

Apparently without any knowledge of what Weir or Serson had done, a machine of exactly the same kind was independently devised and constructed by the late Mr. Troughton in 1820. It consists in causing a disc, truly balanced on a fixed pivot, to spin round with great velocity, so as to keep up its motion during the time required for an observation, known by the name of "Troughton's top." The disc carries a plane reflector on its upper surface; and, being a cylinder hollowed out at its lower end, and the point of support within, the centre of gravity is thrown below, so that it is in stable equilibrium when at rest. The velocity is communicated by a separate train of wheels, from which it can be instantly detached. Thus set going it would acquire a momentum which would keep it steadily rotating uninfluenced by the motion of the ship. Such at least was the expectation formed from the acknowledged "stability of rotation."

It may be proper here to observe, that, simple as this idea was, the practical application of it involved several instances of those mechanical resources which its inventor could so readily supply. One of these (of importance in all similar instruments) is the means of obviating the unavoidable inequalities of density in different parts of the most accurately cast metallic disc, as well as defects in accuracy of form, which affect the perfect equilibrium. These were remedied by plugs, or small pieces of metal, screwed more or less deeply into holes made for them at opposite parts of the circumference, three vertically and three horizontally placed, by which, in successive trials, a complete compensation was effected.

The method was, however, practically found to fail. But the cause of failure was by no means understood at the time, nor indeed till some years afterwards, when it has been satisfactorily traced to another mechanical principle. The pivot partakes in the irregular motion of the ship. When the disc is not revolving, this motion is in turn communicated to the disc; and the centre of gravity being below—the very circumstance which gives it stability on land—causes it to acquire an oscillatory movement. When in rotation, this does not show itself directly, but is compounded with the rotation, and causes a precessional motion, which is fatal to its use as a horizontal reflector, as at once appears from considering the principles of rotation at first laid down.

At the same time there were, no doubt, cases under peculiarly favourable circumstances when this plan might be resorted to. So much, however, was the want felt of a method which could be generally relied on, that several other schemes, not dependent on rotation, were successively proposed by naval officers and men of science for obtaining an artificial horizon at sea.

Of such inventions (including those of the late Admiral Beechy, of a glass floating on mercury, of Mr. Fallowes by a vessel of mercury suspended from the sextant, and others,) it would be hazardous to speak without reference to actual experience; but it is believed that, though several such plans have been recommended by professioual authority, and may be occasionally available under particular circumstances, yet most of

them have been found in some way inconvenient or inefficient for general use; and the cause of failure might in several instances be traced to mechanical principles now better understood than formerly, especially where the principle of suspension is involved, as just explained.

Thus the thoughts of inventors were again turned to the fertile principle of rotation, and, on reconsidering more attentively the causes of failure of the top of Troughton, as arising from the pendulous oscillation, it became evident that to remedy this difficulty we might cause the centre of gravity of the disc to coincide with the point of support, as would be readily done by suspending the revolving disc with its axis and pivots in rings constructed as gymbals, in the manner of the gyroscope of Bohnenberger already alluded to, and thus this cause of irregularity would be avoided.

Having thus the principle of a stable plane secured, still it would remain to bring it to the true horizontal direction, or at least to have the means of determining that direction or the deviation from it.

To this object accordingly Professor C. P. Smyth's attention was directed. Several modifications of the spirit-level had been suggested for this object; but the sound principle of its application was soon seen to be attainable by a simple combination of mechanical and optical means, whence Professor C. P. Smyth was at length led to a very simple, complete, portable, and efficient construction.

As this construction itself is of an optical nature, and not connected with rotation, it would be foreign to the present object to describe it in detail; but we may just mention that it consists essentially in the bubble of a spirit-level reflected from a diagonal mirror above it, seen through a collimating lens, so adjusted that in one inclination the apparent position of the bubble coincides accurately with the true horizontal direction, whence it is easily demonstrated that in every other inclination, within certain small limits, the apparent place of the bubble will deviate from its former place by the same angle as that by which the base is inclined, or will in all positions give the true horizontal direction, the level-tube being bent into a small arc of a circle, whose radius is equal to the principal focal length of the lens.*

Such an instrument being supported on the perfectly balanced rotating disc, into which we have supposed Troughton's top converted, the observer will be thus furnished with a direct view of the true horizontal point with which the image of the sun or star can be brought into coincidence in the usual way with the sextant.

But for other classes of observations on board ship, which involve the direct use of the telescope, especially where one of considerable power is requisite, the condition of invariable stability is yet more necessary, though hitherto unattained.

One of the most important instances of such observations are those of the eclipses of Jupiter's satellites, which it is well known afford so ready, easy, and accurate a method of obtaining the longitude, but hitherto found inapplicable at sea from want of the means of mounting a telescope so as to be free from the motion of the ship.

* This contrivance has been fully described in the Notices of the Royal Astronomical Society, vol. xviii. p. 65, Jan. 1858; it was also exhibited at the Paris Exposition in 1855, and described in a printed notice.

Attempts, however, to attain this object have not been wanting. Indeed the suggestion seemed obvious of some means of this kind, arising out of methods commonly practised on board ship, for giving a kind of stability required for the ordinary purposes of life, such as suspending a table on slings, by which it is, in a certain sense, rendered comparatively steady, so that articles keep their places on it; for example, a glass of water placed on it does not spill.

This effect, however, when more carefully considered, is seen to be only one of the same kind as the common experiment of whirling a vessel of water over the head without spilling; the surface of the water keeps perpendicular to the string, not parallel to the horizon.

When we consider the case as to its mechanical conditions, it readily becomes apparent that a body thus suspended is like a plumb line, when the point of support is itself set in motion it acquires a part of that motion, and from a plumb becomes a pendulum; and it oscillates more irregularly and violently from the accumulation of motions impressed upon it continually by every fresh motion of the ship. The case is the same as that just considered in Troughton's top, but here distinctly displaying itself without any concealment from compounding with other motions.

The invention, which formerly obtained considerable celebrity, called Nairne's or Irwin's "Marine Chair," for carrying the observer and his telescope, was simply an application of this principle. It was tried on board ship, especially in a voyage to the West Indies, by the late Dr. Maskelyne; and, though somewhat prematurely rewarded by the then government, was found not to answer, though no one seemed fully aware of the cause of its failure till Sir J. Herschel (in the "Admiralty Manual") pointed out the principle just stated, and showed that this free suspension must tend to increase and perpetuate disturbances rather than destroy them.

In these cases the centre of gravity is below; this is what constitutes the table or chair a pendulum. If it were suspended in gymbals, so that the centre of gravity should be at the point of suspension, the tendency to oscillate from this cause would be overcome; but still any slight cause might disturb the level; there would be no principle of permanent stability, or tendency to restore the equilibrium when lost.

Yet that, under occasional and very favourable circumstances, this, or any like plan, might be found available, it would be difficult positively to deny. It has, in fact, been alleged that observations have sometimes been effected in this way; but we must suppose that it can only have been in the hands of peculiarly skilful observers, and that the case is quite exceptional.

We have noticed the causes of failure in several apparently promising suggestions for attaining the desired stability; we have also hinted generally at the channel through which a better expectation appears to be opened. To produce this desired stability for a plane or stand on which the telescope is to be rested, we must have recourse to the free revolving disc accurately balanced within gymbals on its centre of gravity. But in following out the details of such a construction there are many points to be attended to. In the first place, agreeably to what was before observed, it will be evident that the equability of density in the mass requires to be carefully secured, and the balancing must be perfected by means of the

adjustable plugs before mentioned, both in the disc and in the gymbal frames; the pivots of the gymbals must be of perfect workmanship, to turn with the least possible friction, yet without looseness or displacement; an immense rotatory velocity must be communicated to the disc by machinery, of which its suspension must be quite independent, so that the moving power can be instantaneously withdrawn. All these conditions are fulfilled in the form of the machine which, after repeated trials, has been adopted by Professor Smyth, exhibited by him at the Paris Exhibition in 1855, and successfully tried by him on board Mr. Stephenson's yacht Titania, on his voyage to Teneriffe in 1856.*

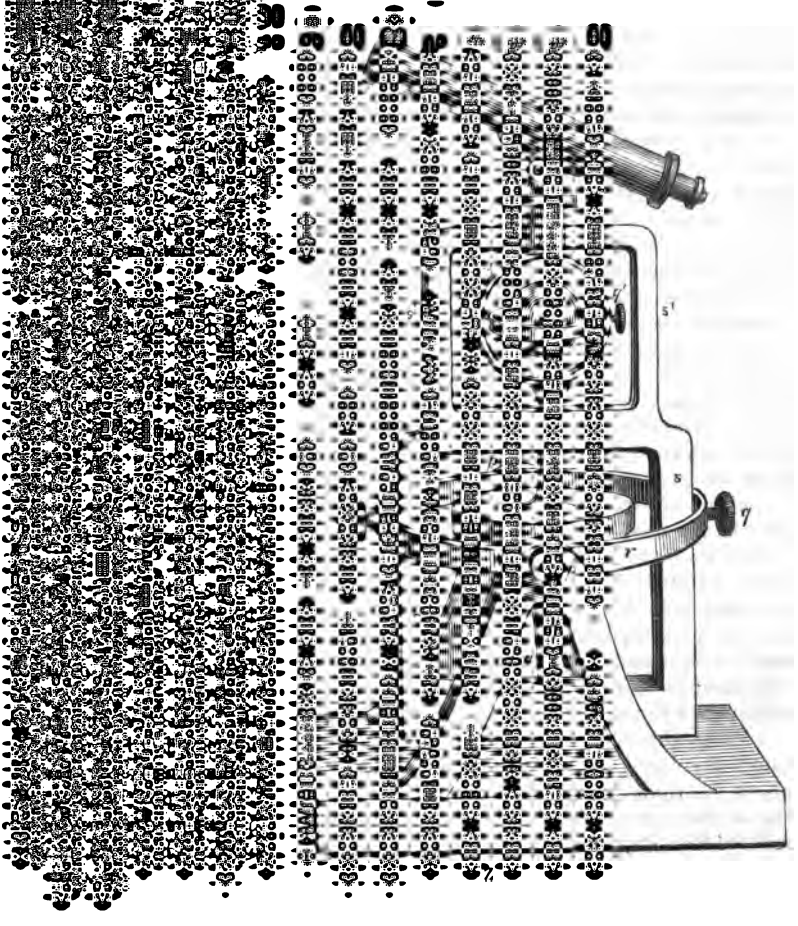
The machine is in fact simply a gyroscope, but of a form peculiarly modified to suit the special purpose for which it is intended.

To explain the principle of its action, we must consider the general conditions of the case.

In the first instance, it may be necessary to bear in mind that a telescope pointed to a star may undergo a motion of translation to any extent, and in any direction, provided it retain strict parallelism to its original position, that is, remain pointed to exactly the same altitude and azimuth, and it will retain the object in its field just as if it were absolutely fixed. This (it is obvious to any one acquainted with astronomy) is simply the result of the absence of parallax in the heavenly bodies within the limits of these observations, and applies even to distant terrestrial objects. Thus, if we imagine a ship going in a perfectly straight course on a perfectly level sea, or even if its motion on the waves were confined to one straight direction up and down, this parallelism might be retained; but this, it need hardly be said, is not the actual case, even if the course be perfectly straight, so that the motion of the telescope, in this respect, is perfectly of a parallel kind, yet still the pitching and rolling take place by angular motions, in planes respectively parallel and perpendicular to the length of the ship. The slightest angular motion is destructive to the parallelism of the telescope. It is against this, therefore, that it is our object to guard.

Now to explain the manner in which this result may be obtained, we have merely to recur to the general mechanical principles already laid down; and from these it will be at once understood that, in the construction of the gyroscope or revolver suspended in gymbals, the grand principle of fixity of the plane of free rotation is that which enables the revolving disc to retain parallelism to its original plane, however the external frame or pivots supporting the whole be moved. From this principle the revolving disc resists all angular change of position in directions perpendicular to its plane, but it offers no resistance to any motion in that plane. Thus, if set spinning horizontally, it will resist all angular motion impressed in a vertical plane, either by the pitching of the ship in the direction of its length, or its rolling in the direction of its breadth; but it will not resist lateral motion in a horizontal plane, such as any shifting of the ship's head towards the points of the compass.

* See a paper "On the Angular Disturbances of Ships, &c." by Prof. C. P. Smyth, F.R.S. Trans. of Royal Scottish Society of Arts, vol. iv. part 4, 1857; also Astron. Society Notices, vol. xvii. p. 36. A full notice of the whole subject will also be found in the American Annual of Scientific Discovery for 1859, by D. A. Wells.



The axis $p'\,p'$ goes through the upper part of the frame, and to this is attached the support on which may be fixed either the telescope, as represented, or an artificial horizon.

In such a construction we have supposed the observer to stand or sit on the deck of the ship, himself exposed to the motion from which his telescope is exempt; and in this manner were Professor Smyth's trials of the machine on board the yacht actually made; and, from the large amount of motion to which so small a vessel was liable, it may be concluded that a severe test of the capabilities of the method was afforded. The trial appears, however, to have been perfectly satisfactory; but, doubtless, the use of the telescope under such conditions would require considerable skill and practice on the part of the observer, both of a nautical and of an astronomical kind.

The great difficulty being thus got over, it may, perhaps, be thought better not to embarrass ourselves with mere refinements of construction to meet objects which, though of much convenience and value, are not equally essential.

Yet it is evident that, for nice observations, it would be a great advantage to any observer, however skilled, to possess the means of partaking himself in the stability given to his instrument. It may thus not be without interest to devote a few further remarks to the possibility of securing an object of such evident convenience.

Now it is obvious from the nature of the construction that in theory, at least, by a mere enlargement of the scale of the machine, the same stand which carries the telescope might be made to carry the observer also, which would be a material convenience for any nice observations. But a practical difficulty arises: the essential condition is the preservation of perfect equilibrium about the centre of motion. Now if this were secured by proper compensation for the observer in one position, the slightest change of position on his part would vitiate that arrangement.

The observer, instead of being an extraneous source of disturbance to the supports, and thus incapable of producing any impression on the balanced and revolving system, now becomes a part of it, and thus impresses upon it a fresh motion, arising from every slight change of posture, which alters the exact position of the centre of gravity of the whole. This effect, however, would not manifest itself directly, but, being compounded with the rotation, would show itself in a precessional motion, fatal to the stability of the direction of the telescope.

But even the difficulties thus arising may be shown to be capable of being obviated by a mere extension of the same principles as those already appealed to. And though this form of the construction has not been as yet been practically tried—as indeed, its merely secondary importance has hardly seemed to render necessary—yet Professor Smyth has clearly explained the conditions of the case, and fully described a construction by which the evils are obviated.

In fact, the remark above made points to what would take place in a single revolver. If we merely suppose two such revolvers, having their pivots at right angles in a common exterior frame, but both rotating in the horizontal plane, so that one be corrected for pitching, the other for rolling, then any slight disturbance of the equilibrium of the whole would

be resisted by one of the revolvers, according as it might tend to turn the frame about the line of the exterior or of the interior pivots of the entire frames. The resisting revolver would show the disturbing force compounded with its rotation, and giving a tendency to precessional motion, which, when the speed was great and the disturbance small, would be long before it was completed, and thus, for the time, preserve the stability.

Thus, as Professor Smyth observes, "If any want of balance is produced on the frame, it is not immediately altered thereby, the first effect being only to make the appropriate wheel turn on its gymbal pivots. If, too, the wheel is heavy and the speed great, this precessional turning will be so slow that there will be time for an attendant to press in the opposite direction on the general frame, and correct the effect of the observer's want of balance, before the plane of rotation coincides with the direction of the disturbing force, when the virtue of resistance ceases."

To strengthen the effect, and at the same time to give a more convenient balance to the whole, the two discs respectively are reinforced each by a corresponding revolver at the other end of the same diameter of the frame, and similarly mounted in the inner general frame.

Thus all angular disturbance in vertical planes being got rid of, it only remains, on the principle before described, to add a fifth revolver in the middle, in a vertical plane, to counteract angular horizontal motion. The inner general frame supports a vertical frame, which carries this last revolver. Thus we have the construction of "the compound precessional free revolver stand," as the inventor designates it.

It is hardly necessary to add that, in all forms of the apparatus, the motion is communicated by a separate train of wheels, exactly on the same general principle as before described. But, to complete the whole, Professor Smyth has carefully investigated the best form of a train of wheels for communicating the rotatory motion; and has also considered the question of the best moving power to be used—which he finds, after many trials, to be that of water—which is best brought to bear by a peculiarly beautiful and simple form of the turbine.*

* This is fully described and figured in the paper before referred to.

Wednesday, May 25th, 1859.

Captain PACKE, in the Chair.

The ACCLIMATION of EUROPEAN TROOPS for SERVICE in INDIA, and the ORGANIZATION there most SUITED to SECURE EFFICIENCY in the FIELD.

By James Bird, Esq., M.D. F.R.C.P., and late Physician General Bombay Army.

Among the mountain ranges of the western ghats of India, the Neilgherries, and elevated spurs of the lofty Himalayan chain, districts and climates, suitable for the healthy residence and vigorous existence of the European race, have of late years been eagerly explored, and as rapidly made the settlements of English invalid officials. The best known and most frequented of these hill stations are Aboo and Mahabaleshwar on the west, for the Bombay presidency; Ootakamund and the other Neilgherry stations for Madras; Darjeeling for Calcutta and Bengal; Simla, Nynee Tal, Landour, and Mussoorie, for Bengal and the north-west provinces; and Murree and Dalhousie for the Punjaub. The experience of thirty years has established that the climate of these stations is congenial to the feelings and health of Englishmen, and that, as permanent residences, they are suitable for our population, in so far as their limited extent of territory permits; and that the out-door labours of settlers would not, for eight months of the year at least, be interrupted by the excessive rain-fall, which, for successive days of the four months of the Indian rainy season, is found amounting to 10 or 24 inches of rain daily. Along with the introduction, therefore, of the railway system into India, flattering schemes for the colonization of these hill stations, and the cantonment there of a large English force, have been perseveringly and glowingly set before the Government and the public, as encouragement for both to liberally subscribe their money for the practical completion of such schemes. Some of these recommendations, however, more particularly their military occupation as acclimating stations for troops, have been made without due knowledge and consideration of the physiological changes effected in the human body, under change of climate and locality; or of the hygienic conditions under which such changes, and the acclimation of Europeans, with the results of their efficiency for service in hot climates, can be most effectually obtained. In fact, the elevated table-lands, or plateaux, above which several of the hill stations rise, such as Dapoorie, on the same high plain as Poona, or 1,900 feet above the sea-level, have been somewhat incongruously spoken of as hill stations, and recommended, in the same breath with the last, for extended military occupation. But the conditions of climate peculiar to the former, and the organic physiological changes effected by residence there, which form individual constitutions suitable for hot climates, are altogether different from those experienced at higher elevations of from 4,000 to 7,000 feet; where elevation is accompanied by the same diminution of temperature as met with in temperate latitudes, or in this country, but from which European soldiers, after years

of healthy residence, would, on descending to the lower plains for military service, suffer nearly as much as if under direct and immediate transference from temperate to equatorial latitudes; where, as already recommended in my former lectures, the best means of assimilating the raw soldier's constitution to new employment and climate will be to remove, as far as possible, all local and topographical causes of unhealthiness; and to neutralise, at the same time, the hurtful agencies of extreme and variable temperature, or excessive dryness and humidity, by well-regulated systems of diet, clothing, exercise, and amusement, along with the healthy sites of the soldiers' tents, barracks, huts, and hospitals.

Certain increased ratios of sickness and mortality among masses seem inseparably associated with certain degrees of latitude; the average of human life, under equal circumstances, being shorter in proportion as we are near the equator, and lengthening gradually as we approach the pole. Such higher or lower averages seem mainly dependent, as a whole, on higher or lesser degrees of temperature and moisture connected with particular latitudes, and are inversely as the degrees of latitude. They are also relatively greater or less, in the inverse ratio of elevation of site and locality, when the diet, clothing, and social and moral habits of individuals are alike and placed under equally sanitary conditions of a dry soil, good drainage, and an open country, more exposed to sea than land breezes. The conservative influence of insular maritime climates is greater than continental sites in the same degrees of latitude, and is probably one reason why the per-centage of mortality for age in England is less than that of France. In the southern provinces of the latter country, where the climate is warmer, the average mortality of the population is a tenth greater than in the northern provinces, or 1 in 33 to 1 in 44; and yet it is not from the last, but from the former, that troops for service in Algeria are taken, as their constitutions, after a few years' residence there, are found better able to resist the morbific influences of a hot climate, and the disturbed physiological actions of constitution incident to all cases of transference from different climates and localities. To avoid, therefore, the probability of any great increase of the ratio of sickness and mortality, among troops under transference from cold to hot climates and localities, it is desirable that the transference should be effected at that season of the year when the conditions of climate and country to which troops will be exposed are found to vary least from those conditions characteristic of the climate and locality they have just left. In selecting, then, particular elevated sites and localities for military occupation in hot climates, the question is not one merely of the highest elevation, possessing climatic conditions of the temperate zone, and the consequently diminished chance of engendered malarious influence and sickness; but at what altitudes and in what localities of India, and other hot climates, can large bodies of troops be best cantoned and habituated to varied and elevated temperature; and to the moisture of these climates, so as to keep down high ratios of sickness and mortality among soldiers, and render them most efficient for service in the field. If the question was only one of colonization or permanent occupation, without chances of removal to service and fatigue in a warmer atmosphere, the choice, without any risk of failure or disappointment in result, might be given to the greatly elevated and colder hill climates of

India, met with at the height of between 6,000 to 8,000 feet. But, on the subject of military occupation and the cantonment of troops, it plainly resolves itself into conclusions from facts, as to the final results for armies best prepared for field service; or, in other words, what climates and localities of India are most calculated to effect that sanitary condition of European military masses, so as to render them least susceptible of morbid impressions, during exposure to heat and other causes of disease incident to field-service in that country: where, out of any given number of men, entering on such service, and accustomed to a hot climate, there will be the greatest amount of efficiency in the field, under a decreasing ratio of sickness and mortality. The answer to these queries, and their solution, mainly depends on a right appreciation of what essentially constitutes for strangers in a new climate, and under its modifying climatic agencies, that altered constitutional condition which ends in health for the new comer, with the possibility of living in and resisting the diseases of the country nearly as well as those who are indigenous to it. These modifying atmospheric agencies are temperature, density, moisture, and electricity; the nature and composition of the soil and locality, with its extent of easting, and proportion of continent or otherwise; which, continually acting on the body, effect in due time a special modification and interchange of organic functions, which adapt individuals and masses to the new conditions of their existence.

Some, from having confounded together two orders of agencies, the atmospheric and endemic or miasmatic causes of disease, absolutely deny the possibility of acclimating Europeans in hot climates. Mons. Baudin in France, Sir Alexander Tulloch and Mr. Martin in this country, incline to this view:—which is, however, opposed by the enlarged experience and well-considered opinions of Dr. M. Levy, MM. Celle, Perier, and Aubert Roche in France, and of many other experienced army medical officers in this country. Dr. Levy says, "According to the investigations of Sir Alexander Tulloch, it has been advanced that prolonged sojourn, far from promoting acclimation, increases the chances of mortality; and statistics, always pliant and flexible for every kind of paradox, have crowded their group of figures around this opinion. Soundly-observed facts refute it however. From 1,220 military who died in Algeria, and taken at random, three-fourths had not exceeded a residence of 17 months. We have also noticed the progressively numerical decrease of men discharged: for, out of 1,575 dysenteric cases that came under observation during 10 years in Africa, 338 belong to the first year, 235 the second, 150 the third, 86 the fifth, 35 the seventh, 17 the eighth, and 2 the last two years."*

These preliminary observations on the subject of localizing and acclimating European troops on hill stations in India bring me to the consideration of the three following heads of this lecture:—

1st. If acclimation be possible, what is the nature of that physiological adaptation of European constitutions for hot climates that assimilates them to the same standard of organic action incident to the organism of the indigenous inhabitants, and confers on them a nearly like immunity from certain diseases?

* Traité d'Hygiène Publique et Privée; par Michel Levy, Medicin principal d'Armée, &c. tome i. p. 568.

2nd. The elevation and condition of the stations and climates of India most desirable for placing European soldiers beyond the range of aggravated attacks of fever and bowel complaint, and most suitable for producing that kind of constitutional adaptation by which they may be rendered most efficient for field-service.

3rd. What practical lessons may be drawn from the consideration of these questions, and what organisation of European troops in India would secure most efficiency on service, and with greatest good to the State?

I shall endeavour to treat these points in a comprehensive but brief manner, still sufficient, I hope, to convey to my hearers definite ideas of a difficult subject; obscured as it has been, in some measure, by incongruous elements of morbific causation, such as yearly decrement of constitutional power by age, augmented by miasmatic influences of locality, not having been separated from atmospheric causes by those who obtained statistical figures and results, to prove that in hot climates there is no acclimation. But, if acclimation be possible, what are the proofs of it? I have already quoted the opinion of the well-known French army physician Dr. Levy, that according to his experience the contrary opinion of this is a paradox. Indeed, it is true only in this way, that the law of yearly increasing mortality from five years of age onwards, and which, for Europeans, prevails with the smallest ratio of mortality in temperate latitudes, when exaggerated by transference to equatorial latitudes, and other elements of increased morbid causation, not ameliorated by suitable sanitary arrangements for climate and locality, gives a large and continuously-increasing ratio of physical degradation and mortality. The operation of this law, among masses of men, gives the least statistical ratio per 1000 for the civil population of England, or a mean of 8·45; while in Prussia, France, and other continental states, it increases to 10· and 11·25 respectively. But the relatively mean ratio of mortality under this law, when sought for among the soldiers and officers of the English army at home, is 14·52,* and among those of the French army 15·10;† showing that the soldiers' separation from the influences of his natal place, climate, and association, increases on the whole his physical degeneration—even under home residence and climate. The mean ratios of mortality among the French military at home, and of English troops in Ireland, under this law, compared with the respective means for the troops of both nations under hot climates, are to be seen in Table III. The home ratios, having been calculated for years when the sanitary condition of soldiers was little attended to, are higher than those obtained from later years. What wonder, then, that under transference to equatorial latitudes, and augmented sources of unhealthiness unremoved, and not ameliorated by suitable sanitary provisions and arrangement, statistical figures and results should

* In the tables handed in by Sir Alexander Tulloch, in support of his evidence before the commissioners appointed to inquire into the organisation of the Indian army, the mean of cavalry and infantry is given at 15·52. The other table there, corresponding with No. VI. I have taken from Mr. Marshall.

† The mortality of Europeans under military life, and in increasing ratio according to residence and proximity to the 1st degree of equatorial latitude, is increased by advance of age, transition from native climates, transference to tropical latitudes, unremoved sources of endemic disease, and bad sanitary arrangements for soldiers in respect of their diet, barracks, clothing, and exercises.

have been obtained to speak so loudly against the possibility of constitutional acclimation, or adaptation of the nervous, circulating, and excretory functions necessary to contend against the changed conditions of life in a new climate. We may at once learn, by a reference to Table VII., how this law of yearly-increasing mortality for age, per 1000 of the civil population, operates in this country; and by Table VI. we may see how, by the same law, an exaggerated ratio of mortality takes place among the military on transference to our colonies. In latitudes north of the equator it is least in the Ionian Islands, being 19·8;* but in southern latitudes, under the rather hot climate of the Cape of Good Hope, and where but few sources of miasmata exist, it falls to 17·6, being only 3·8 above the mean ratio for this country.

"Change of climate," says Dr. Levy, "is to be born to a new life. Some changes become necessary in the vicarious or alternate functional action of the principal organs, in the regimen, and habits moral and social; but so complete ought these changes to be that they may be effected without necessarily producing either disease or death. The gift of elasticity of our fibres, the gift of extent of our functional oscillations, is conferred on us for accommodating ourselves to new influences collectively, in order to plant ourselves in every place where humanity is represented by some one of its numerous tribes. But this is under the condition of conforming to things necessary for the transition, and of combating, by attention to hygienic modifiers, the assaults of climate and irregularities of organic action. That the statistical mortality of Europeans in hot climates need not be a subject of exaggerated fears, we repeat that it proves less the radical unhealthiness of certain climates than the deleterious conditions, but correctible, of their topography, such as the existence of marshes, and vast masses of organic matter. It proves above all the baneful consequences of neglecting the laws of hygiene."

The operation of age, in diminishing constitutional vigour, and thereby increasing the yearly ratio of mortality among bodies of men, is sensibly felt and appreciable, under all conditions and in every quarter of the globe. The statistical results, therefore, of this operative law necessarily increase, in proportion as those subject to it are exposed to additional causes of morbid causation in hot climates, and such as have been mentioned; but, though we cannot altogether bring down the mean ratios of mortality of hot climates to the standard average of temperate ones, we have still within our power the removal of certain endemic sources of disease in localities, and to so train the changing organic functions of the body into a healthy state, under altered conditions of elevated temperature, for purposes of assimilating a majority of European constitutions to hot climates, and with results of having mean ratios of sickness and mortality among troops, not greatly in excess of those incident to our own country and like temperate zones. If this were not the case young soldiers in India, under exposure to elevated temperature and fatigue, would be quite as healthy as the old or seasoned ones; while the very reverse of such result is found to be the experienced opinion of old military and medical officers. The acclimation so acquired, and by which old soldiers

* In the second of Sir Alexander Tulloch's tables before quoted this is given at 16·4.

can outwork the younger ones on a campaign, is not mere experience gained by residence; but partially a physiological adaptation of constitution to new conditions of life, with improved physical qualities, for accommodating itself, under fatigue, to those conditions.

The adaptation to the changed conditions of hot climates, independent of miasmatic sources of disease, must be gradual and progressive for unacclimated masses of strangers, and imposes on them the necessity of shorter or longer sojourn in intermediate regions, with proper attention to moderate eating and drinking, selection of season for landing in the new climate most akin to that which they had just left, and, after arrival, fixing on habitations and localities free from miasmata, protected from land winds, and under the salutary influence of those from the sea; together with the resolute adoption of suitable diet, clothing, and exercise. Such care and attention become necessary, in order that certain organic functional actions, in more elevated temperature, may be reduced in force, and so regulated as to be brought into vicarious healthy action in place of others, and to aid some, lessened in power and activity.

At page 31 of the Appendix to Minutes of Evidence taken before the Commissioners appointed to inquire into the Organization of the Indian Army, Returns 34 and 35 are given, in illustration of the comparative beneficial results of transference of regiments to India, after sojourn in the intermediate climates of Australia or the Cape, and of direct transference from England. While the result of these Returns makes questionable the propriety of transferring troops from our Australian colonies, they bring out the benefit of doing so after a sojourn at the Cape. The mortality of five regiments sent from the Cape to India, after the first year of service, was 4·8 to 11·0 among eight regiments sent direct from England; and if the ratio of mortality for three additional regiments at the Cape be added to the former ratio, we obtain the comparative beneficial results of transference from the Cape and from England as 7·21 per cent. to 11 per cent. of their strength. Nothing can be more conclusive than this of the possibility and benefits of graduated acclimation to elevated temperature, apart from the miasmatic influence of locality. The superiority of residence at the Cape over the graduated influence of a sea voyage, is thus brought out. Acclimation too of troops in India, under suitable sanitary arrangements, as not only practicable, but an obvious result among old soldiers, when they have become seasoned, is further substantiated by many valuable facts brought forward in Mr. Willoughby's able and consistent evidence, given at p. 267 of the Commissioners' Report, as well as by much that is admitted in the evidence of the medical witnesses; for at page 171 of the Report, and in reply to Major-General Hancock's question, "Does not a greater mortality prevail among young officers and soldiers than among those who have been eight, ten, or twelve years in India?" Mr. Martin answers, "Yes, always; the mortality is greater among the young, the improvident, and, if I may so call it, the unseasoned. I am afraid to say anything which should lead to the conclusion that there is such a thing as acclimation; but that kind of accommodation of the habit and constitution occurs in every country in the world, not in India alone. The army of Napoleon broke ground from Boulogne in 1805, he marched 400 French leagues to the battle of

Austerlitz, they were all old soldiers, they were exercised, no room was left for idleness, and there were hardly any sick on the roads. When he went again, in 1809, to the battle of Wagram, the roads were lined with youths who perished." Is not this corroborative of the opinion I hold, in common with many celebrated physicians and physiologists, "that there is virtually a physiological adaptation of constitution to new conditions of life, with improved physical qualities?" This, too, is an adaptation which not only prepares them for greater fatigues during a campaign, but exempts them from attacks of many severe diseases incident to marching in hot climates, particularly cholera and sun-stroke. Regarding the exemption from the latter enjoyed by old soldiers, Sir Robert Vivian, in his evidence (p. 137 of the Report), adduces, in support of his opinion that Europeans can be seasoned, the superintending surgeon, Dr. Arnott's, medical experience, "that it was a somewhat remarkable fact of two European regiments engaged in the affair before Kooneh, on the 7th May, 1858, the right wing of H.M. 71st Regt., about 425 strong, had twenty men attacked with sun-stroke, of whom seven died, while the portion of the 3d Bombay Europeans, about 330 strong, had not only no casualty from, but no man attacked by, this disease, though both corps were equally exposed to the same causes of disease, and under circumstances apparently precisely similar. The 3d Europeans had an average service of three years in India, the 71st arrived in Bombay the preceding February, 1858.

Acclimation, then, in hot climates being admitted as a physiological and practical result, I come to the second part of the inquiry, "What should be the elevation and condition of stations and climates in India most suitable for producing that kind of constitutional adaptation, by which men may be made most efficient for field service?" Not certainly in the more elevated mountain climates of India, within the range of 4,000 to 7,000 feet, where diminution of temperature produces climates akin to those of the temperate zone, and associated with kindred organic functional actions of the body as are met with in those; except that calorification and respiration are less energetic from the diminished density and oxygenation of the air, while the processes of sanguification and nutrition are more venous and incomplete, with a greater concentration of blood in both the lungs and digestive apparatus. Their limited extent, too, may scarcely admit of large bodies of soldiers being acclimated there, and it would be found on experience that, like the indigenous inhabitants of these mountain ranges, Europeans so localised, when brought down from the hills for service in the plains, during the rains and hot weather, would be quite as sickly under the transference, and die in as great relative proportions as men brought direct from England. Elevation of site in equatorial latitudes is accompanied by nearly like climatic conditions as are met with in the temperate zone, and with the same preponderance of certain functional actions of the organism as distinguish its inhabitants and vegetable productions. Special modifications and interchange of these functions would be as necessary, under transference to the elevated temperature and other altered climatic conditions of the plain, as when required for improving the health of Europeans, recently arrived in India.

On this subject Sir George Clerk, in his evidence, page 195 of the Commissioners' Report, says, that locating European troops on the

mountains of India is a false measure; and that with good barracks placed at certain commanding points on the plains of India, they would be more healthy than they are in the West Indies, or in many other colonies. If by commanding points he means, such dry sandy plains as Deesa, or the high plateaus of Poonah, Belgaum, Dharwar, Bangalore, and such like elevated places in the Bombay and Madras presidencies, I entirely concur with this opinion, that with good barracks, and under suitable sanitary arrangements for diet, clothing, and exercise, the ratios of mortality per 1,000 would be so reduced as not to exceed those of temperate climates. In all of these places, much of their healthy character is evidently due to the dryness of the site. At Deesa, in the northern military division of the Bombay presidency, where the elevated temperature sometimes exceeds 110° of Fahrenheit, the ratio of mortality, for 10 years, 1847-57, was 21·9 per 1,000; at Poona, 10·7; at Belgaum, in the southern division, 19·; at Bombay, 55·5; and at Bangalore, in the Madras Southern division, 23·8. At Aden, in Arabia, a very dry locality, but hot climate, the ratio per 1,000 is only 25·2. Soldiers cantoned at elevated sites, ranging from 2,000 to 2,500 feet, would be more efficient in the field, and more able to bear up against hardships and exposure on actual service, than those stationed at higher elevations and under conditions of climate more nearly akin to those existing in the temperate zone.

Stations of this kind, where large bodies of troops may be cantoned and acclimatised for Indian service, are everywhere available through the wide extent of the Bombay and Madras presidencies. Selection of moderately elevated sites for Bengal proper, that may be rendered healthy for troops, by means of good drainage and well-constructed barracks, is a matter of more difficulty, from the general flatness of the country: but for the north-west provinces, many eligible and elevated sites may be chosen for locating European troops. Dryness of site, gravelly character of soil, and freedom from masses of organic matter, should be always of the greatest importance in determining a preference of selection for such stations.

Mere elevation of site, without other essential conditions of endemic health, will not necessarily secure low ratios of mortality for troops. Reference to Tables IV. and V. for the ratios of mortality according to elevation of site in the tropical latitudes of the east and west, indicates that at elevations much higher than that of Poona, and other like healthy localities, where, from the nature of the soil and site, endemic sources of malarious disease are allowed to exist, the ratios of mortality per 1,000 will be still found very great, and little or at all below those attainable for troops localised on the plains—facts sufficiently instructive in guiding us to the most necessary sanitary arrangement for soldiers in hot climates, namely, to select, for their barracks or encampment, eligible sites and localities, where there is no accumulation of surface-drainage, and no relative sources of miasmata in the vicinity.

In the Madras presidency, the average ratios of mortality for five years will be found least in the presidency and Mysore divisions of the army, including Bangalore, being respectively 25·5 and 23·5. Within the ten military divisions of that presidency, though there are some very elevated sites, still they are most unhealthy from those endemic sources of disease we have mentioned, and there are many others that

might be yet selected with great advantage for the localisation of troops. Among the elevated but unhealthy sites within this presidency, it will be instructive, on this subject, to notice that in the Mysore division the sites of Seevasamoodrum and Seringapatam, elevated about 2,000 feet, have been found very destructive of European health, while many other localities of the same division, peculiarly productive of fever in former times, have since become perfectly healthy; and in others the very reverse has taken place, shewing the main sources of European unhealthiness are endemic miasmata, and not mere elevated temperature, to which the human organisation adapts itself. Seevasamoodrum is surrounded by water and jungle, and near one of the falls of the Cavary. In other districts of this presidency the ravages of fever and other miasmatic diseases are not stayed, even at an elevation of nearly 5,000 feet, where their endemic sources are allowed to exist. In the Travancore province of the southern division a considerable plateau of table-land, 4,740 feet high, and in the vicinity of Trevandrum, but not yet thoroughly explored, is said to be healthy. Again, in the Salem district of the same division, the table-land of the Shivaroy hills, at a general elevation of 4,600, and but scantily clothed with vegetation, is not beyond fever range after falls of rain. During the dry months they have been found perfectly healthy; but the breaking out of a fatal remittent form of fever among the European residents there, during June, 1824, caused them to be deserted. It is not mere elevation then that we have to look to for European health in India, but to an eligible and perfectly well drained and dry site for European soldiers.

I come now to the third and last point—What practical lessons may be drawn from the consideration of these questions, and what organisation of troops would secure most efficiency on service, and with greatest good to the State? The previous observations made, and the statistical facts adduced in proof, that old and seasoned soldiers are superior in endurance and physical qualities to young unseasoned ones in India, have partly anticipated the solution of these problems. Lord Ellenborough in his evidence, p. 293 of the Commissioners' Report, fully bears out this opinion in the statement that he saw 100 men of the 9th Lancers, who had never seen an enemy, die within the first year of their residence in India. At the utmost strength of cavalry regiments this would be fully a sixth of their strength. The possibility of acclimating troops to mere elevated temperature being possible, and the adaptation of their constitutions being followed on service by lessened ratios of sickness and mortality, form one of the strongest grounds for a considerable organisation of European troops for local service in India; independent of those financial and political considerations, which, for the ultimate safety of our Indian empire, strongly urge on us the necessity of this measure. It is not within the province of this lecture to discuss the financial and political bearings of the question, that there should be a large permanent European force maintained in India, and proportioned to the moveable force of the British Army, always subject to the periodical reliefs from home. The permanent force should be at least two-fifths of the moveable force—say 32,000 to 48,000 men of the regular Army, from among whom, on being relieved to return home, European colonists for hill stations, and recruits for the permanent local force, might be obtained.

In concluding the exposition of the medical questions that have been mooted, we may draw the following inference:—

1st. That the law of constitutional deterioration—greater mortality for age in hot climates, beyond the ratios of like age in temperate ones—can be greatly reduced in operation by removing endemic sources of disease, and by selecting suitable dry localities.

2nd. That in the most insalubrious tropical countries, the selection of good positions, on dry elevated table-lands, suffices often to secure for European troops a perfect sanitary state, nearly equal to the more salubrious regions of the temperate zone: this salubrity varying, however, in a remarkable manner with the geographical latitudes and longitudes of places.

3rd. That the increasing ratios of mortality for hot countries mainly depend on unremoved surface drainage, and the generation of miasmata in places occupied.

4th. That the morbific influence of seasons and climates in producing disease is in direct relation to and dependence on the quality of the soil, the latitude, the longitude, the elevation of the place, its northern or southern exposure, and the national temperaments and races of soldiers who may be there located.

TABLE I.—GENERAL MORTALITY of the ENGLISH ARMY at HOME and ABROAD, from 1819 to 1828.

Years.	Effective Strength in the United Kingdom.	Deaths.	Ratio of Deaths per 1,000.	Effective Strength beyond the United Kingdom.	Deaths.	Ratio of Deaths per 1,000.
1819	53,380	493	9	54,992	3,755	63
1820	54,527	740	11	50,557	2,584	57
1821	37,988	620	16	51,277	2,220	42
1822	41,530	560	13	46,709	2,692	57
1823	40,786	566	13	48,995	1,981	40
1824	42,585	651	15	49,888	2,257	45
1825	57,048	854	16	53,755	3,849	71
1826	48,826	1,082	22	58,339	4,513	77
1827	47,747	824	17	58,440	3,713	63
1828	46,193	828	18	58,592	2,844	47
Total . .	470,610			531,534		

TABLE II.—MORTALITY of ENGLISH TROOPS from WAR, and under TRANSITION to OTHER COLONIES.

Places.	Authorities.	Period of Observation.	Annual Mortality per 1,000.
Cape of Good Hope . . .	Official Reports, 1818 to 1836	1818 to 1836	15·5
New Scotia and New Brunswick .	Ditto	1817 to 1836	18·
Malta	Ditto	1817 to 1836	18·7
Canada	Ditto	1817 to 1836	20·
Gibraltar	Ditto	1818 to 1836	22·1
Ionian Islands	Ditto	1817 to 1836	28·3
Mauritius	Ditto	1818 to 1836	30·5
Bermudas	Ditto	1817 to 1836	32·3
St. Helena, 1816 to 1822, and from 1836 to 1837	Ditto	.. ..	35·
Tenasserim Provinces . . .	Ditto	1827 to 1836	50·
Madras Presidency	Quetelet	1826 to 1830	52·
Bombay ditto	Ditto	1826 to 1830	55·
Bengal ditto	Ditto	1826 to 1830	63·
Ceylon	Official Reports	1824 to 1836	57·2
Antilles and Guiana. . . .	Ditto	1817 to 1836	85·
Jamaica	Ditto	1817 to 1836	143·
Bahama	Ditto	1817 to 1836	200·
Sierra Leone	Ditto	1819 to 1836	483·

TABLE III.—COMPARISON of the MAXIMA and MINIMA of MORTALITY of FRENCH and ENGLISH TROOPS in TEMPERATE and HOT CLIMATES.

TEMPERATE CLIMATES.				HOT CLIMATES.			
Periods and Departments of Service.	Mortality per 1,000.			Periods and Departments of Service.	Mortality per 1,000.		
	Maximum.	Minimum.	Mean.		Maximum.	Minimum.	Mean.
FRENCH. Infantry for 6 years in France, 1820 to 1826	23	15	19·4	FRENCH. In Algeria 5 years, 1838 to 1843	104·	49·	76·5
ENGLISH. Troops in Ireland 32 years, 1797 to 1828	20	10	15·	ENGLISH. In the Antilles and Guiana 19 years, 1817 to 1836	152·8	40·6	96·7

TABLE IV.—INFLUENCE of ELEVATION and LATITUDE in DIMINISHING the RATIO of MORTALITY among EUROPEANS in HOT CLIMATES.

Countries and Latitudes.	Stations.	Elevation in feet from the Sea.	Mortality per 1,000.	Remarks.
Saint Lucia, 13° 50′ north	Mount Fortunate	850	122·	
Jamaica, 17° to 18° 30′	Up Park Camp	200	152·8	
	Stony Hill	1,360	96·	
	Maroon Town	2,000	32·	Deducting deaths of sick brought there, only 22
Ceylon, 6° only of north lat.	Kandy	1,670	60·7	
	Badula	2,100	97·1	
	Nieur-Elia	6,200	24·	
Mysore	Bangalore	2,400	22·	In 1849 only 16 per 1,000·
Neilgherry Hills, in lat. north 11° 10′ to 11° 32′	Ootakamund	7,116	20·	

TABLE V.—INFLUENCE of PROLONGED SOJOURN in INCREASING the MORTALITY of HOT CLIMATES.

Places.	Length of Sojourn.	Periods of Age.	Mortality per 1,000.	
Ceylon . . .	Below 1 year	—	44·	
	1 to 2 years	—	48·7	
	Beyond 2 years	—	49·2	
Jamaica . . .	Below 1 year	—	77·	
	1 to 2 years	—	87·	
	Below 2 years	—	81·	
	Beyond 2 years	—	93·	
Cape of Good Hope .	3 years	—	8·	The mortality here given is only of one Regiment, the 72nd; of which the effective strength is unknown; but still progressively increasing in a country where malarious influences on mortality is scarcely appreciable.
	4 ditto	—	13·	
	5 ditto	—	12·	
	6 ditto	—	16·	
	7 ditto	—	13·	

TABLE VI.: from Mr. MARSHALL.—INFLUENCE of AGE on the ANNUAL MORTALITY of every 1,000 EFFECTIVE MEN among ENGLISH TROOPS at HOME and ABROAD.

Places of Residence.	Mortality per 1,000 from Age.				Mean Mortality per 1,000 at all Ages.
	From 18 to 25 Years.	From 25 to 33 Years.	From 33 to 40 Years.	From 40 to 50 Years.	
United Kingdom { Cavalry of the Line	13·9	14·	17·8	26·7	15·3
United Kingdom { Horse Guards	14·7	11·4	16·3	22·8	14·5
United Kingdom { Foot Guards	22·3	22·5	17·7	27·5	21·6
Gibraltar	18·7	28·6	29·5	34·4	22·3
Malta	13·	23·3	34·	56·7	22·3
Ionian Islands	12·2	20·1	24·4	24·2	19·8
Antilles	50·	74·	97·	123·	67·
Jamaica	70·	107·	131·	128·	91·
Bermudas	16·5	42·	42·	76·	28·9
Canada—Upper and Lower	19·7	27·7	37·7	35·7	25·7
New Scotia and New Brunswick	14·	22·5	30·8	41·5	20·3
Cape of Good Hope	9·	20·6	29·7	82·	17·6
Mauritius	20·6	38·	52·7	86·7	34·7
Ceylon	24·	55·	86·4	126·6	48·3
Bombay	18·2	34·6	46·8	71·1	33·1
Madras	26·	59·3	70·7	86·5	52·2
Bengal	23·8	50·3	50·6	83·3	44·5

TABLE VII.—MEAN ANNUAL PROPORTION of MORTALITY among every 1,000 LIVING INDIVIDUALS of the ENGLISH CIVIL POPULATION above 4 YEARS of AGE, 1838 to 1841.

Age.	Ratio of Mortality per 1,000 Living Males of every Age.	Age.	Ratio of Mortality per 1,000 Living Males of every Age.
Under 5 years	70·97	From 60 to 70 years	43·60
From 5 to 10 „	9·48	„ 70 „ 80 „	91·98
„ 13 „ 15 „	5·24	„ 80 „ 90 „	201·73
„ 15 „ 20 „	7·30	„ 90 „ 100 „	461·93
„ 20 „ 30 „	9·91	„ 100 and above	454·79
„ 30 „ 40 „	11·30		
„ 40 „ 50 „	15·00		
„ 50 „ 60 „	23·01	General Mean	23·16

Evening Meeting.

Monday, April 18th.

Captain E. G. FISHBOURNE, R.N., C.B. in the Chair.

The Chairman announced that sixteen Members had joined the Institution since 21st March.

LIFE MEMBERS.

Rhodes, Godfrey, Major unatt.
Shadwell, L., A.Q.M.-Gen.
Gore, Jas. A., Major 71st High. L. Inf.

ANNUAL SUBSCRIBERS.

Deane, E. P. Esq., Hon. Corps Gent.-at-Arms
Strahan, Wm., Lieut. R.A.
Reynolds, J. W., Lt.-Col. Dep. A. Adjt.-Gen.
Swan, P., Capt. 3rd R. Middlesex Mil.
Muttlebury, G. A., Lieut. 4th Drag. Gds.
Travers, F. S., Capt. 60th Rifles
Stanhope, W. S. Capt. 1st W. York Yeo. Cav.
Maxse, F. A., Captain R.N.
Hay, T. H. V. D., Ens. Cape M. Rifles
Dowman, Jno. Capt. of Invalids, Royal Hospital, Chelsea
Wray, H., Capt. R.E.
Percival, E. A., Capt. late 11th Huss.
Parker, C. W., Capt. 4th Roy. Midx. Mil.

NAMES of MEMBERS who have paid increased SUBSCRIPTIONS since 21st March.

Boustead, J., late Paym. Ceylon Rifles
Burdett, C. S., Lt.-Col. Coldstream Gds.
Yonge, G. N. K., Major Depôt Batt.
Walker, W., Capt. late 69th Regt.
Bailey, L. C., Master R.N.
Wilson, S. F., Capt. 55th Regt.
Norton, Jno., Capt. late 34th Regt.
Reynolds, J. W., Lt.-Col. D. A. A.-Gen.
Burgess, G. F., Com. R.N.
Griffiths, Julius G., Lieut.-Gen.
Stanhope, W. S., Capt. 1st W. Y. Yeo. Cav.
Read, C. H., Lieut. late Ceylon Rifles

DONATIONS.

	£	s.		£	s.
Rhodes, Godfrey, Maj. unatt. . .	3	0	Skey, Dr.	1	0
Burrell, Justinian, Capt. R.N. . .	0	10			

PRESENTS.

LIBRARY.

Books.

Military Transport by Sea. Pamph. 8vo. London, 1859.
Presented by C. Alexander Wood, Esq.

Blue Books:—Report of the Progress of the Ordnance Survey and Topographical Depôt to 31st December, 1858.

Report of the Commissioners appointed to inquire into the best means of Manning the Navy; together with the Minutes of Evidence and Appendix. London, 1859.
Presented by Lieut.-Col. J. F. D. C. Stuart, Gr. Gds. M.P.

W. J. Trery, Esq.—A Study Book of Civil and Mechanical Engineering. No. IV. Folio. London.
Presented by Mr. Jobbins.

Sir John F. Davis, Bart. F.R.G.S.—China during the War and since the Peace. 2 vols. 8vo. London, 1852.
Poetry and Criticism. 1 vol. 8vo. 1850.
Hien Wun Shoo. Chinese Moral Maxims; with a free and verbal Translation.
Chinese Novels. Translated from the Originals, &c. London. 8vo. 1822.
Presented by the Author.

National Life Boat Institution, Journal of. Vol. IV. No. 32.
Presented by the Institution.

Royal Artillery Institution.—Occasional Papers. No. 10. March, 1859.
Presented by the Institution.

Royal Society.—Philosophical Transactions. Part III. Vol. CXLVII. for 1857. Part I. Vol. CXLVIII. for 1858. List of Fellows, 1858. *Presented by the Society.*

Views of British Military and Naval Burial Grounds in the East. 1 vol.
Presented by Her Majesty.

Maps, Plans, Engravings, &c.

22 Engravings of Musketeers. *Presented by Commander G. F. Burgess, R.N.*

MUSEUM.

Miscellaneous.

Models of the Crimean Monuments in Inkerman stone. *Presented by Her Majesty.*
Nine Bullets ploughed up in Naseby Field. *Presented by G. Ashby Ashby, Esq.*

Military.

10 specimens of Powder Cases; 9 specimens of Pig Iron used in casting Ordnance at the Royal Arsenal, Woolwich; 1 Head of Sponge for 32-pounder; 1 Block of Wood for ditto; 1 Fleecy Hosiery Coating for ditto; 1 Bolt Tire with Nut, 6-pounder gun; 1 Spoke (oak); Portion of Wheel, 9-pounder gun. *Presented by Secretary of State for War.*
Staff-Sergeant's Chaco worn in Infantry Regiments from 1805-7.
Presented by Mr. H. White.

THE SCREW FLEETS OF ENGLAND AND FRANCE.

By C. L. Pickering, Esq.

During the course of last summer, the two greatest naval powers of the day had each a squadron composed of ships of corresponding classes, anchored at the same time within the artificial roadstead of Cherbourg.

Questioning, as I ever shall, the policy of allowing the ships of both nations to mingle together in peace-time, and to act in concert as much as they have of late years, as in Vourla Bay, at Naples, Constantinople, or Cherbourg, an opportunity has at all events been afforded at those meetings, to the officers of both fleets, of comparing the qualities of the respective ships.

If any one thing could have struck an observer more than another, it must have been the marked contrast between the ships of England and France at the first and last of these meetings, comprising a period of barely twenty years. It seems but the other day since the "Royal Albert," "Curaçoa," and "Euryalus," on the one side, and the matchless "Renown," formidable "Diadem," and "Raccoon," on the other, encircled that *chef-d'œuvre* of nautical elegance, simplicity, and good taste, the Queen's Yacht, the whole forming a picture on which many a British officer gazed with delight; and crowds of wondering foreigners who but a short time

back had fully expected to see our ships make a bad show, and had been but too ready to take for granted the unjust comments of our press, now stood staring with awe and admiration. As the gratified seaman scanned the straight sheer, trim set, and faultless rig of the English ships, he could not help recalling that such had not always been the case, and that the comparison, in some particulars at least, had invariably been against us. How different, for instance, was the appearance, ship for ship, of the fleet under Admiral Stopford, with that under Admiral Lalande, at a time too when the rival fleets looked not very lovingly on each other, when the towering "Montebello" lay near our own three-decker "Princess Charlotte," which in herself scarcely averaged the size and broadside weight of the fine French two-deckers of 100 guns, against which class we find even Sir Charles Napier, who then commanded the "Powerful," lamenting, in a letter to Lord Minto, that we could only match undermanned ships of 80 guns, as the "Thunderer," and his own, and the wretched, unsightly 72's, such as the "Benbow," "Revenge," and "Bellerophon."*

The fact is, that these few years have accomplished a wondrous development in naval architecture. The advent of Sir W. Symonds to the surveyorship of the navy began the change, and the introduction of the screw completed it. Under Sir W. Symonds were exploded all the theories and traditions of the old school of shipbuilding; the captured line-of-battle ships and frigates, from French and Spaniards, which had slavishly served for our models, were supplanted by designs of his own; while the lumbering old craft that had carried their guns nearly flush with the water's edge, in which our forefathers fought against such odds with Frenchmen, Spaniards, Dutch, and Danes, from the time of the Tudors till our own, were discarded for ever. Sir W. Symonds clearly proved, by the noble ships which he built, and the emulation his example excited in the profession, that, when unrestricted as to tonnage, the bane of his predecessors from the time of Mr. Petts and Sir Anthony Deane, England could produce naval architects second to none.

I shall not enter into the much-disputed question engendered by the particular merits or demerits of Sir W. Symonds's ships, than which, Sir James Graham once observed in the House of Commons, "he knew no subject except religion that had excited so much bitter controversy." I am quite aware that they had defects, which, in the eyes of the better judges, in some degree nullified their good qualities, and possibly militated against their fitness for action.

Still it remains an established fact, that, despite the opposition from the more regular trained ship-builder, a profession in which every naval officer will not fail to detect more jealousies and heartburnings than in almost any other, civil or military, he was a great and natural genius, and a benefactor to the British navy; for never before his time had English ships been noted for beauty of form above water, capacity of fighting-deck, swiftness of sailing, and stiffness.

The magnificent "Queen," for instance, the most perfect embodiment of his theory, which once went to Malta in ten days, and which, from the time of her launching to the introduction of the screw, was scarcely if ever

* Sir Charles Napier, Letter to Lord Minto, Dec. 4, 1839, p. 126. Past and Present of the Navy.

out of commission, had a long and successful run, and was declared, by no less a judge than the present Surveyor of the Navy, at the time he commanded her, to be perfect on all points.

Sir Charles Napier, whose earnestness in everything connected with the navy is above all praise, and who had been for years the most consistent and persevering opponent of Sir W. Symonds, ultimately bore the same testimony to her good qualities, and expressed a hope in one of his letters that our future three-deckers might be built on her model; a hope which may be said to be carried out to the letter, for our present "Duke of Wellington," "Royal Sovereign," and "Marlborough," are no other than lengthened "Queens."* The noble "Vanguard," the parent of our present two-decked ships, which in 1840, during the motley combinations of fleets in the Archipelago, was conspicuous for her neatness, order, beauty, and swiftness, was another case in point. The Prince de Joinville, an excellent judge, bears testimony in his writings to this splendid ship, and on the occasion of her heading the Turkish fleet, commanded by that subsequent arch-traitor the "Capitan-Pasha," through the Pass of Tenedos, acknowledges that when she passed the French fleet, as if to display, as he himself asserts, her superiority, she elicited the admiration of all the French officers; he adds in the original, "Nos yeux jaloux n'y pouvaient trouver rien à critiquer, il justifiait tout ce qu'il est possible d'attendre d'un peuple marin par excellence,"†—a testimony which, it is not too much to assert, no British ship before her ever elicited from a foreign naval officer. The same might fairly be said of the host of beautiful vessels, whose stiffness in carrying sail, and power of going to windward, are forgotten and despised, and which, nevertheless, by being slightly altered and elongated to meet the requirements of the screw, prepared the way for our "Duke of Wellington," "Agamemnon," "Impérieuse," and "Highflyer," and were further improved for steamers, as experience suggested, and time rendered necessary, into our "Marlboroughs," "Renowns," "Emeralds," and "Pearls."

From these considerations I shall at once enter into my subject, by the enumeration of classes and rates in both fleets. Singling out the most powerful ships, we come at once to the LINE-OF-BATTLE SHIPS, those which, along with heavy frigates, are the more immediate representatives and exponents of the naval power of a nation—the *vaisseau de ligne*, or, simply, *vaisseau de guerre*, of the French; for the term *vaisseau* is never applied in France to anything less than a ship of the line. They comprehend, as of old, such as, from their superior size and armament, are considered of sufficient force to compose the line of battle—to take part in a general engagement—the individual force of each being determined by a regulation from the Board of Admiralty signifying the number of guns mounted, and which has varied greatly throughout all classes since the introduction of the screw. Whilst the like discrepancy may be observed in the French service, the old rates being retained officially, the number of guns in peace time is made subservient to the nature of the service, it being current in the French fleet that even bow and

* Letter to the Right Hon. Lord John Russell, p. 185. Past and Future of the Navy. Sir Charles Napier.

† Essais sur la Marine Française, par le Prince de Joinville. Paris, 1852.

quarter guns would be immediately added in case of collision with a first-class naval power.

Of first-rate line-of-battle ships there are in the British screw navy three classes of armament: as the "Marlborough," "Royal Sovereign," of 131 guns each; the "Victoria," "Royal Albert," of 121; and a third anomalous class, comprising but two ships, the "Windsor Castle" and "Royal George," of 101 guns each; the French numbering two classes, in the "Bretagne," of 140 guns, and the "Louis XIV." of 120.

At the head of all these afloat, and until the "Howe" and "Victoria" are launched, stands the "Marlborough," the finest, as she is also the largest, man-of-war as yet constructed in this country, and an improvement on the "Duke," which she has exceeded in speed by nearly three knots. Of stupendous size and noble proportions, she may be instanced as an example of the system of conversion carried out fully for efficiency, having originally, like all the others above, been laid down for a sailing-ship of the "Queen's" class of 3,099 tons, but in her case altered, whilst on the stocks, by being sawn asunder amidship, and there lengthened 23 feet, the distance of two ports, 7 feet 6 inches abaft in the run, and further more than the "Duke" 6 feet forward in the bow, making her length outside all 286 feet. She is somewhat higher between all her decks than the "Duke," and of little more power in her engines; but in other respects she is the same as that ship.

It must be a matter of regret that circumstances prevented her escorting the Queen to Cherbourg, where, along with the "Renown," she would have contrasted favourably with the "Bretagne," instead of the "Royal Albert," a ship very much shorter, and which provoked very unjust comparisons from both French and English. As a specimen of the sort of information that obtained currency among us, and went the round of the newspapers, it may be stated that a writer, who very appropriately signed himself a "*Land Lubber*," in a letter to the "*Times*," actually mistaking the French mode of admeasurement of *pont sur pont* for the length outside all, as with us, makes the "Albert" longer by 2 feet, whereas it struck every person, naval or otherwise, that as the ships lay near each other within the breakwater, the "Bretagne," with her enormous number of ports, appeared considerably larger. The fact is, that she is even larger than the "Marlborough," as may be seen by the drafts of both ships. The displacement at the constructor's deep immersion, turning French admeasurement and casting tonnage into English form, which I have done, is greater by 630 tons over the "Marlborough," and by as many as 1,158 tons over the "Royal Albert."

The difference in the length is also great, the "Bretagne" being outside all 92 mêtres, or 300 English feet, exactly the length of the "Victoria," and consequently 14 feet more than the "Marlborough," though of less beam by 3 feet. This last circumstance, and the enormous weight of her engines, very nearly 1,000 tons, being the cause of her deep immersion—a fatal and inexcusable mistake in her designer, for it is difficult to believe that even the Minister of Marine, at that time a landsman, could have entertained the project of a three-decker carrying her guns no more than 4 feet 6 inches from the water's edge, as the "Bretagne" does, though otherwise stiff, as she may prove for carrying sail—an error of judgment

in her designer which might so far militate against her in any protracted service when her coal would fail her, or in a sea-way, when she would be obliged to close her lower-deck ports, so as to make her no more than a match for the class immediately below hers, such as the "Renown." It must be well understood at all times that the height of a lower-deck port out of the water is one great criterion by which to judge of the excellence of a ship of the line.

In blowing weather across the Bay of Biscay, on their way to Cherbourg, the "Napoléon," and, indeed, all the other ships of the squadron, kept their ports open and guns run out, whilst the "Bretagne" could only show two or three of her aftermost lower-deck ports open. All our new ships built for screws carry their portsills, on an average, some 8½ feet above the water. It is worthy of remark, that, whilst an error of calculation is apparent in the "Bretagne," the opposite mistake of not giving enough displacement was committed at the same port, and almost by the same men, in the instance of the three-decker "Valmy," launched, in 1847, at Brest, which was to possess unheard-of qualities for a ship of her class, but which turned out so remarkably top-heavy or crank, on her first trial in the roadstead, that the naval authorities of that dockyard foretold she would never stand under canvas at sea, a condemnation which made it necessary to give her a doubling, or girdling of solid timber, from her lower-deck ports to some few feet below her water-line, an expensive, but at the same time the only, remedy for this blunder, and which will not improve her efficiency as a screw-ship. And yet, while such blunders were being enacted in the French dockyards, a London paper, in noticing that the design of the "Bretagne" had been accepted without any modification by the Minister of Marine, further inserted this paragraph: "It would be thought marvellous if our Admiralty showed the same readiness in accepting the many valuable suggestions made to them!" An opinion which may be endorsed, though not in the sense the writer expected, for they know him little, who think the Surveyor capable of entertaining the scheme of a three-decker carrying her guns no higher than they did in the time of Sir W. Raleigh. The error is the more unaccountable, as the French have till now been generally successful with all their three-deckers. In the Revolutionary war the good qualities of the famous "Commerce de Marseilles," taken at Toulon, were very conspicuous, and few of the frigates could sail with her. Sir W. Symonds always regretted that she was prematurely broken up, and he is said to have embodied her good parts in the "Queen."

But to return to the "Bretagne:" her engine-room and stoke-hole occupy a length of 97 feet of her hold, 30 mêtres, incapacitating her for carrying as much coal as the "Marlborough" by 200 tons, three days' full steaming. Everything having been sacrificed to a temporary full speed, a quality insisted on in France almost at the expense of every other, she has reached 12 knots at full power in smooth water, and is supposed to stow coal enough for 6 days' steaming at that rate, or expansively 14 days at 8 knots. I have been told by her chief engineer, and a careful look at her scantling fully justifies the belief, that she strained considerably in her after part, at that excessive speed, on some portion of her passage from Toulon to Brest in July last, so much so as to make it doubtful whether she could continue it long.

At 11¾ knots, however, she betrayed no signs of weakness, so that her speed for a continuance—and taking the mean average of 11 to 11½ as the results of the different trials with the other fast ships of the squadron, with all their stores and guns on board—her speed will not, I am convinced, be found superior, even if equal, to that of the "Marlborough," which, when properly trimmed under the like condition of sea-service, has reached 10½ and even 11 knots; a result altogether below the expectations of the projector of the "Bretagne," who had reckoned on 13 and even 14 knots after the experiments carried on in the "Pomone," "Phlégéton," and "Napoléon," and which unfavourable results he, of course, charitably attributes to her very defective engines, but which I think may fairly be put to the account of the ship as well. And when I come to add that those engines, manufactured at the national establishment at Indrêt, nominally of 1,200, work only to 2,000, not twice the nominal power, and cost 20 per cent. more in France than if made in England, whilst Maudslay's engines in the "Marlborough," of 800, have worked up to 2,683, very nearly three times the nominal power, and occupy less room by 9,996 cubic feet of space, with just half the number of furnace fires, 24 instead of 48; that the "Bretagne" is no conversion, her designer having had the advantage of laying her down as a screw-ship, and that she was built in the unprecedented short period of two years,—it must be apparent to the most casual observer that, for all practical purposes, the "Marlborough" is the finer man-of-war of the two, and that Sir H. Douglas's suspicions about the general inferiority of the French engines is even now fully borne out.*

In making a comparison between the steam speed of the two ships, I am quite aware that only general conclusions can be drawn from the loose experiments that have been performed in each, but as we are not likely, in peace time at least, to have closer data to go by, I think they will be found sufficiently correct.

The appearance of the "Bretagne" outside, with the exception of her very beautiful figure-head, is not favourable; she is a box of guns, all ports, and has a considerable amount of sheer; her ports, twenty-four in number, on the middle deck, are narrower than our own, and lie very close to one another, being not more than 7 feet 6 inches apart, whilst the "Victoria" has hers as much as 11 feet apart; a very important consideration, and which is strictly observed in all the new ships designed for screws by Sir B. Walker. These dimensions are the results of actual measurement.

In the event of engaging on one side, as at anchor for instance, against a fort, the "Bretagne" will be able to bring to bear the fire of eighty of her guns, whilst the whole number of her ports, including the

* Naval Warfare with Steam. Sir H. Douglas. Introduction, Implied Construction, page x.

This very important consideration, first made known by me in England at this Lecture, has since been endorsed in a very striking manner by no less an authority than Admiral Paris, one of the most scientific and accomplished officers in the French service; for, in his admirable work lately published, I find him lamenting the general inferiority of the boilers put on board French men-of-war, precluding a steam-power in excess of what I have stated. It may be stated, also, that three French officers of rank are in England at the present moment studying this very question.—C. L. P.

bow and stern chasers, amounts to one hundred and eighty. Her bow is good, exactly like that of the "Royal Albert," that is, the foremost port on the middle deck is almost at right angles with the knee, a principle observed in the "Queen" and the other three-deckers commenced by Sir W. Symonds, but which has been departed from in the "Marlborough," "Duke," and "Royal Sovereign," where they come more on the bow, and in the wake of each other, and where the principal reliance for chasing seems centred in the forecastle 95 cwt. gun. Her stern, like that of all screw ships, is more upright than was formerly the case in vessels of her class, and, whilst this disposition is favourable to strength, it has the two marked disadvantages of not protecting the head of the rudder, and of making the shipping and unshipping of it a matter of greater difficulty than heretofore. No quarter piece being added, and the ports and painted streak being continued right round, the French sterns assume a very heavy and ugly appearance; an impression which is not compensated by the caryatides, and other sculptured devices, miscalled ornaments, seemingly out of place in ships of the present day. The value, in a fighting sense, is however not lost, for the "Bretagne," when seen right astern, can fire, when hard pressed, no less than eighteen guns on the plane of her keel right aft,—as many as in the full broadside of a corvette.

With us, setting apart the exception and further improvement of rounding the quarter piece, and continuing the gallery and rails right round, the beautiful elliptical sterns of all our ships of war are exactly what they were when designed by Sir W. Symonds, models of elegance, lightness, and efficiency.

There is a great deal of bright work about the upper deck of the "Bretagne," though not so much as is generally the case in French ships; large brass awnings, or hood stanchions, cover the companion or after hatchway on the quarterdeck; her boats are placed a-head of the funnel, a disposition general throughout the French fleet. Her decks are slightly lower than those of the "Marlborough," and the employment of the old-fashioned knees of wood, instead of iron, adds much to the clumsy appearance of her 'tween decks. If the absence of mess-tables on the lower-deck detracts from the look of comfort, the gun gear and great number of small arms, pistols, muskets, tomahawks, grape, case, fighting lanthorns, which encircle every port, add much to the martial appearance. In the "orlop" is that never-failing eyesore to be found in all French ships, the baker's oven.

There is little to notice in the armament of each ship, unless it be that the "Bretagne" carries so called *carronades à tourillons* along her gangways, over and above her rating, as indeed do all French ships, and that the forecastle chaser is not adopted for the upper deck, an idea being entertained that it would be soon disabled or neutralised by the rifles in an enemy's tops. The "Bretagne" stows three months' provisions for her complement of 1,200 men; the "Marlborough" four months' provisions; and, unlike the cramped-up quarters of the "Bretagne," where the additional funnel-casing greatly encumbers the space on all the fighting decks, and comes in awkward proximity to the main rigging on the quarter deck, as it does to this day on board our own "Agamemnon," where it has necessitated a wire rigging, everywhere on board the "Marlborough" we find abundant air, daylight, and room; her eleven hundred men can live

with comparative comfort on board; and, when the stern necessity shall arise, her hundred and thirty-one guns, we may be sure, will be manned as efficiently, and certainly quite as easily, as the like number of field-pieces would be handled on Woolwich common.

To make assurance doubly sure, in our next specimen of a three-decker, the engines now completed for the "Howe" and "Victoria" are of a thousand horse power, and the scantling of both ships considerably stronger, to bear the increased strain and percussion of their new armaments,—sixty-eight pounders on each deck.

With regard to those antipodes of the last class, the "Windsor Castle" and "Royal George," it would be very surprising if either turned out otherwise than failures, incapable of acting together in fleets, considering that one of them was launched and finished as originally laid down as sister ship to the "Queen," without being lengthened one whit to adapt her for the screw, and that the greater part of the main hold in both, is of necessity taken up with the engine and stoke-hole, encroaching on the stowage space and disturbing the builder's trim by their immense weight. Fitted and armed for sea, they are now what our ninety-eights on three decks were in the late war, apparently larger but in reality of smaller tonnage, and with a lighter broadside weight, than the French two-deckers of ninety-two guns, whilst the comparison as to steam speed is even less in their favour; in fact, they cannot prove else but fine sailing ships turned into bad steamers. It is more than probable, however, that, looking at all the circumstances, and well considering the advanced state in which one was on the stocks, and the expense of converting both into larger and more efficient ships, the means adopted with regard to them have been judicious. Besides which, the French, by whom we must of necessity regulate our classes, have done the same thing; the "Bretagne" being the only three-decker built for a screw, whilst the next in point of efficiency, the "Louis XIV." has only been lengthened a very few feet, and fitted with English engines of six hundred horse power, by Napier, which have enabled her to reach a speed of nine knots, with a light breeze in her favour.

From the following it will appear, that when the "Howe" and "Prince of Wales" are launched, which, according to the First Lord's statement, is to be this financial year, we shall have nine three-deckers afloat, it having been determined to razee the "Royal Frederick" into a two-decked ship; whilst the French by the same time will have seven.

Next in importance to these, the TWO-DECKER takes her station in the line of battle, and, if not deficient in steaming qualities, will doubtless be considered, what she was formerly, a good leading ship, able by her size and power to cope with the largest of an enemy. The two-deckers of the British Fleet may be divided into three classes: as the "Conqueror" of 101 guns, "Renown" 91, and "Cressy" of 81. Whilst those of France, always more uniform in every class, constitute but two distinct classes: as the "Ville de Nantes" of 92, and the "Donawerth" of 80.

Our first-class second-rates, as the "Saint Jean d'Acre," "Conqueror," and "Donegal," are fine and powerful ships, possessing, in as great a degree as the confined stowage of the screw-ship will admit, every requisite for prolonged and arduous service, sailing and steaming with the best of

those of France; but the present 91-gun ship, as exemplified in the favourite "Renown," is undoubtedly the finest specimen of a two-decked ship hitherto built. On every occasion when it has been her good fortune to be in company with ships of neighbouring powers, she has been alike the admiration of British and foreign officers. At the naval gathering at Cherbourg she and the French "Ville de Nantes," launched on that occasion, elicited the admiration of all the better judges.

As we have succeeded in securing a model ship of this class, possessing as much speed as the corresponding French ships, with improved engines of less power nominally, and occupying generally less room, we may conclude that such will be our future two-deckers; and accordingly the "Atlas," "Defiance," and "Bulwark," our forthcoming two-deckers now on the stocks, are all sister ships of the same horse-power. It is to be regretted that we have not a greater number of these immediately available, for Sir H. Douglas has well noticed that the inequality of speed of this class, the most useful of all for general purposes, will altogether prevent their acting together in fleets, or even in squadrons, where the movements under steam must of necessity be regulated by the slowest-going steamer. *

After a great many experiments the French have likewise secured an improved model from their early type the "Napoléon," originally with defective-geared engines with two funnels, which so strained the vessel as almost to use her up in the severe trials to which she was subjected.

The "Redoutable," "Algésiras," and especially the "Ville de Nantes," are all magnificent ships at this moment, directly available for any service. Three of this class, the "Arcole, "Algésiras," and "Eylau," in company and almost in line abreast, steamed from Algiers to Toulon in thirty-six hours in the course of last summer,—a performance unheard of before with ships so heavily armed.

In comparing the finest of the two-deckers of both fleets, as the "Renown" and the "Ville de Nantes," we shall not find the same difference as in the larger classes. Both ships carry their guns high and well out of the water, and have likewise very little sheer. The "Ville de Nantes" has her ports a few inches closer than the "Renown," but not so close as the other French ships of her class. Having been laid down in 1854, she has been designed from first to last as a screw-ship, with a round stern, and all the modern improvements. Her ports are pierced exactly like those of the "Renown," except on the upper deck, where they extend along the gangways. As the hammock-berthing is done away with in most of the recently-fitted English ships, it is evident that the "Renown," like the "Ville de Nantes," might mount eight or ten more guns. The "Renown" is however 10 feet longer at the load water line, and has 1½ foot more beam, than the "Ville de Nantes." Both are fast, steaming their 12 knots.

If we carry our comparisons to the masts, spars, and sails of the two ships, we shall find the same difference as is observed throughout the several classes of both nations.

The "Ville de Nantes" is taunter in her masts and has squarer yards than the "Renown;" her main truck is higher by 15 feet. Her lower mast-heads are slightly shorter than in the English ship.

* Naval Warfare with Steam. Sir H. Douglas. Page 82.

There is also a great difference in the size of the sails, which are still cut with a square leech; for, since the length and weight of the masts and yards of the "Ville de Nantes" are greater than they are in the "Renown," it follows that the spread of canvas must be greater likewise, and the centre of effort at a higher point; whilst the tendency of the "Ville de Nantes" to a little less breadth must tend, all things being equal, to operate against her stability.

As a rule, all the sails, with the exception of the courses, are larger in the French ships. The area of the topsails is greater; that of the top-gallant sails still more so; and that of the royals more in proportion than all the others. Looking at the lower rigging we find that, while the "Renown" is limited, as all our line-of-battle ships are, to nine pairs of shrouds, the French ships have still as many as ten and eleven; a fitment which, while it interferes with the line of ports on the quarter-deck of the "Ville de Nantes," must also act as an obstacle for a ship of war, by holding more wind, and offering a denser mass to the fire of an opponent.

The channels, fitted with iron gear, which would likewise occasion much damage if struck by a shot, are now all discarded in recently-fitted French ships, and replaced by the old-fashioned and more serviceable dead-eye. The main-stay, which in the "Renown" is of 5½-inch wire, is in the "Ville de Nantes" of chain, on that part coming immediately in the wake of the funnel; and, instead of being set apart as the topmast stays and fore and spring stays are with us, come so close that a shot striking the one would sever both. There is little to notice aloft apart from the general heaviness of the rigging of the "Ville de Nantes," except it be a sort of standing rolling tackles, or, more properly, preventer-lifts, on all the lower yards, and extra Jacob's ladders on all the lower tops leading on to the caps.

If we consider the 91-gun ship as the most useful of all the two-deckers, it will be curious to notice the tendency to weight and size since the introduction of the engine on board ship, for it is obvious that the best of these, the "Renown," "Orion," "Victor Emanuel," and three or four more, will be in future warfare what the 74's were of old, a sort of intermediate class between the liner and the frigate, possessing, as those did in the old sailing Navy, those two essential requisites, strength and activity combined—qualities which, apart from those of economy and expediency, will most assuredly not be found in the new razees of this class, as the "Queen," "Trafalgar," "Neptune," and the other sailing three-deckers cut down and converted into 91's, and fitted with engines of 500 horse-power; and still less in the 81's, which have been officially condemned *en masse* by the Surveyor of the Navy, in the extract read by the First Lord, on the question of the Navy Estimates. And here, as it bears upon my subject, I will quote the last paragraph.

"The latter, from their great age, are so defective that they will not be worth repairing after their present commission. To show the superiority of the French ships of the corresponding class 80 guns, it may be stated that five were reduced from 100 and ten from 90-gun ships, and are, therefore, not only more powerful sailing ships but better enabled to stow their machinery, &c. than the English 80-gun screw ships."

Now, I have not the slightest means of knowing who the Surveyor's

informant was on this occasion. It is the duty of our Admiralty to be informed of all that goes on in the French dockyards, and they doubtless know it well. But all I can say is, so far as it has come under my own personal observation, the extract is literally true. Some of the ships alluded to formed part of the *Escadre d'Evolution* under Admiral Romain Desfossés at Cherbourg; two of these, the "Eylau" of 92 guns, and "Ulm" of the same force, are conversions from sailing 100-gun ships, altered and lengthened on the stocks; whilst the third, the "Donawerth" of 80, carried the flag of Admiral Lavaud, the second in command, and lay abreast and off the central fort on the breakwater at the review. She, too, is a conversion from a 90-gun ship. All these ships have square sterns as the old sailing class, the round stern being only seen on those ships which were begun as screws. The "Tourville," which lay in ordinary on the north side of the second basin, fitted with an elliptical stern, a copy of our own, is another case in point. The whole of these ships have ample room for their machinery, as their dimensions could show; and which is certainly more than can be said of the "Colossus," "Goliath," "Mars," and a great many more, which a writer in the United Service Journal has held up as paragons of this class, and urged on the attention of the Surveyor of the Navy. It may be very safely asserted that such ships will never reach the fast two-deckers, and much less the magnificent transports, as the "Finisterre," "Arriège," and "Sêvres," of which the French now possess many; and which, singly or collectively, and heavily laden as they may be, each with its 3,000 men and 200 horses, are designed to outsteam any man-of-war, large or small.

Be that as it may, however, it will be found, by comparing the efficient two-deckers of the two nations, that they stand about on a par as to number; 28 on each side, if we include the "Duncan," "Hood," "Revenge," the two last launched this year, as well as the remaining two-deckers to be razeed into twos; the advantage on our side being in half a dozen 80's not included in that enumeration; a very unsatisfactory result, unprecedented in naval history since the days of Charles the Second, and which fully bears out all that has been advanced upon the subject by Sir John Pakington and Lord Hardwicke.

Frigates.—In enumerating the classes of frigates, I shall look upon the modern screw-frigate as likely to be in future actions what she was formerly, the eye of the fleet; and not more capable of entering into the line now than ever, which some think to be the case; an opinion which might have held good had the frigates and line-of-battle ships of other powers not increased in the same ratio as our own.

Apart from the large experimental frigates, as the "Orlando," "Ariadne," and "Doris," and the exceptionable "Termagant," about the size of a French corvette, English screw-frigates may be divided into two distinct classes—the "Emerald" of 51 guns, and the "Curaçoa" of 31; the French numbering two classes, in the "Impératrice" of 60 and "Isly" of 40.

The "Emerald" is the finest frigate of the fleet, her hull exhibiting the symmetry of the cutter, increased to the proportion of the frigate. Her

engines of 600 horse-power have averaged 13 knots; a greater speed than has yet been reached by any ship in the Navy, except the "Orlando," "Fairy," and "Banshee," and very superior to that attained by the two finest frigates of France, the "Impératrice" and "Audacieuse," both of 200 more horse-power. She carries coal enough for nine days' steaming, and seems to solve the one important problem, that both hull and engine must be equally perfect to carry into effect the full powers of both, and also restores in herself the former inequality of speed between the line-of-battle ship and the frigate, an inequality that ought still to exist in the Steam Navy; for it is evident that the "Chesapeake," "Euryalus," and "Impérieuse," having no advantage over the larger ships in this respect, are all liable to be overtaken and forced into unequal encounters with such vessels.

The "Emerald" is 2,913 tons—larger by 31 tons than Nelson's favourite "Victory;" though 25 feet longer at her load-water line than the "Euryalus," she has the same number of ports, 16 on her lower deck, thus increasing the roominess of her quarters and area of her decks.

In this respect she forms a striking contrast to the crowded quarters of the "Impératrice," which numbers as many as 24 ports on a deck only 2 or 3 feet longer, and where the additional length seems only to have brought on an increase of guns, and consequently of weight, which, without affording any influence in a fighting point of view, will more probably seriously militate against the equally-important question of speed and stowage; characters of immense importance in a man-of-war of any sort, but more especially in a screw-frigate.

The "Emerald" carries her portsills no less than 8 feet 10 inches above the water; she will consequently in bad weather be fully equal to an 80-gun ship. And of her we may justly say what was said of Sir W. Symonds's ships, that for that romantic beauty which makes a ship an object of poetry, and charms the eye of a seaman, like that of Cooper for instance, above every other object, no man-of-war or craft of any sort, French or English, can be compared to her. Indeed, as a whole, whether at anchor, reposing on her shadow, as Canning has so poetically expressed it, or bowling along under canvas, the 51-gun frigate of the Screw Navy must always appear the *beau ideal* of a ship, as long as the type of the beautiful afloat is supposed to be embodied in a ship very straight in her sheer, almost upright in her sides, and topped by three slender tapering masts, not overcrowded with rigging. The "Melpomene" and "Narcissus" are her sister frigates, and now figure as our adopted models, while the "Phœbe," "Phaeton," "Severn," and "Sutlej," fully lengthened, irrespective of expense, will prove if not equal to the "Emerald," at least only second to her, and there can only be one regret, that we have not a score more like them available for service. The French "Isly," named after that battle in "Algeria," won by Marshal Bugeaud, whose figure-head she bears, is an ugly but serviceable vessel, as are all the second class frigates in the French service. The "Impétueuse," "Impératrice," and "Audacieuse," the finest models of French frigates, are very splendid and powerful ships, looming in the distance like heavy liners; still the eye will, I venture to predict, fail to detect an "Emerald" among them.

CORVETTES.—Next after the frigate, and now almost imperceptibly merging into that class, both by their weight and size, come the corvettes, for such a frigate as the "Dauntless" would be considered a corvette in France; the largest of which, like the "Challenger," seem well adapted to share in the minor duties of the frigate class, whilst the smallest answer the purpose of the corvettes-avisos of the French. It must be within the recollection of all, how the little "Miranda" was chosen to be the pioneer of the Baltic fleet in the late Russian campaign, and how efficiently she did her duty.

English corvettes may be divided into three classes; as the "Pearl," of 21; "Miranda," 15; and "Racer," of 11; and the French into two classes; as the "Assas," of 16; and the flush-deck avisos-corvette, as the "Biche," of 10 guns.

The "Pearl" is the finest ship of her class yet built; she is 1,462 tons; within 100 tons of Mr. Pett's famous three-decked ship the "Royal Sovereign," built in the reign of Charles the First. She steams a full 11½ knots, and carries her guns high out of the water. To follow an example already given in the French corvettes à batteries-couvertes, as the "Assas" and the "Duchayla," the Admiralty built the "Clio," "Challenger," and "Racoon," with a covered maindeck battery, being, to all appearance, frigates. It is to be regretted that the last of these vessels has turned out crank, and sails and steams very indifferently for a vessel of her class.

The "Orpheus" at Sheerness, but more especially the "Barrossa" now building at Woolwich, restored to a flush-deck corvette uncovered over head, lengthened a full 25 feet, and enlarged by some 300 tons, are however fully expected to meet all the new requirements of a first-class corvette, and to possess that one great qualification for a light cruiser, steam speed. It may be a consolation to know that, if we have not been very successful in this class, the French have fared no better; their best models are in every way inferior to our own, in speed, capacity, and the other attributes of a man-of-war.

After the corvette comes the BRIG; but this vessel is now discarded from the navy since the introduction of the screw; its place being supplied by the smaller steam-sloops and GUN-BOATS, a class of vessels which will prove very destructive for close in-shore service, for which they are especially designed.

It cannot be denied, however, that on the only occasion in which they were tried *en masse*, as at Sweaborg, their fire was a comparative failure. Numbers of officers, English and French, are unanimous in asserting that the good old-fashioned vertical fire from the mortars was alone efficient; and Sir Charles Napier draws attention to the fact, that had the contractor's mortars not been shamefully deficient, or their number too small, the whole of the defences, and even the island, might have been destroyed, and a passage opened into the harbour. It is certain that even now no very successful and definite model has been produced of a steam gunboat, either here or in France. Their limited speed, compared to all larger than themselves; vulnerability to shot (for their safety will altogether depend upon the frustration of the aim of the enemy); the frequency of

their incurring damage in their engines, almost constantly out of repair, in any sustained operation; their fore-and-aft rigging, so little adapted to a war-vessel, cramping up the quarters; and their uneasy motion at sea, rendering both shot and gun almost uncontrollable in even moderate weather; all these concomitant disadvantages will much circumscribe the services of these vessels, if we judge of them as men-of-war, destined to perform the numberless duties that devolved on all the smaller craft in blockading service in the late war, and not consider them as packets, performing the remarkable feat, for vessels of only two inches keel, of going round the Cape.

It may be doubted whether the last French models are not, without exception, the very worst designs in either navy; and, if in trying to meet all these objections, the remedies are not worse than the evil. In the French service an idea prevails that the operation of gun-boats close inshore, or up rivers, might be altogether paralysed by a well-trained rifled musketry.

Having so far described each class from the two extremes of naval efficiency, the steam line-of-battle ship to the gun-boat, it will be apparent that steam has altogether inverted the ratio of speed that formerly existed between the different classes of men-of-war. With the sailing-vessel the principal aim being to obtain speed under canvas, with the means of readily manœuvring before an enemy, it became imperative to keep ships, especially line-of-battle ships, destined to act together in fleets or in squadrons, comparatively short, to enable them to fulfil these conditions to the best advantage; speed being obtained in the small vessel by the increased relative area of canvas spread; the cutter, for instance, spreading more than the brig of double her tonnage; the corvette, required of all others to be fast, doing the like by the same means. Thus in the old sailing navy we find the smallest vessel without an equal in speed when sailing by the wind, and even bearding the frigate in the chase; the heavy liners bringing up the rear slowly but irresistibly after the frigates and the corvettes, leaving these last the option and power of flight before an enemy superior in size.

The requirements of steam speed necessitating corresponding horse-power, and consequently greater space on board ship, have now entirely changed these conditions, and given that advantage to the larger vessels, to the obvious detriment of all the smaller classes.

In the early days of the screw propeller, our Admiralty, no doubt anxious to maintain the first relative speed unimpaired, seemed to have acted on this assumption, and accordingly we find the "Royal Albert," of 400 horse-power, with a speed of five or six knots; the "Impérieuse," of 350, with ten-and-a-half; and the "Highflyer" with the same; the whole averaging what at that time seemed a more than sufficient speed for any auxiliary or actual fighting purpose, and one and all lengthened just enough to admit the engine and boilers, and quite irrespective of the influence length might possibly have on the ship's speed, an influence at that time very imperfectly known but since ascertained to be great.

The exigencies of the Russian war in 1853-4 requiring a sudden accession of sea-force, and it being compatible with economy, a number of paddle-boat engines of weak power were forthwith turned over to some of

the 91's, which were being fitted in great haste to join the fleet. In every instance these engines have proved failures.

The "Megæra's" engines have proved so bad in the case of the "Algiers" as to make it advisable to discard them altogether for new and more powerful ones. Those of the "Vulcan" by Boulton and Watt, in the "James Watt," likewise proved so defective in her last commission, as to turn a very splendid ship into a slug; so that the sooner the like change is made in her, and also in the "Hannibal" and "Nile," the better will it be for their efficiency as steam men-of-war. Not so with the French; who, having a smaller *materiel* to work on, disregarding all minor considerations of economy, as they always do in aught pertaining to war, or where efficiency alone is at stake, and anticipating that speed either collectively or singly will in some degree hold the place of seamanship in action; and having moreover very different warlike requirements to meet, both in the narrow seas and on the ocean, with fast steaming squadrons of frigates and heavy liners, avowedly intended to skim the seas of everything weaker than themselves, to act against our coast, or in desultory operations on our commerce, gave their ships a horse-power since ascertained to be in excess of what their scantling could bear. Under such circumstances, and to be more on an equality, there seemed no help but to follow, and, however reluctantly, to partly adopt, the same system; and thus horse-power, tonnage, length, and unfortunately—for this is the most serious of all, and there is no help for it—draft of water also, have gone on increasing to meet the requirements of pending service. Sir H. Douglas, probably foreseeing the disadvantages in a tactical point of view, is most anxious that sloops and smaller vessels should be capable of exerting greater steam-speed than the liners, and that the former balance should be restored,* though there seems no clue how this desirable point is to be attained, unless by immeasurably increasing the size of ships of lesser rate, as the Americans have attempted to do, and as we appear to have successfully done in the "Orlando," "Mersey," and the "Emerald," but have failed as yet to accomplish in all our corvettes, sloops, and gun-boats; whilst the French have likewise further failed in their frigate classes.

Thus it remains pretty certain, that, whilst the motive power is steam, generated by the combustion of a fuel requiring enormous carrying space for stowage, and both engine-room and stoke-hole necessitate some two-thirds of a ship's hold, the screw man-of-war, from the line-of-battle ship to the gun-boat, can be no other than a very large ship.

In looking at the noble ships of each rate, now on the eve of being launched, and which from first to last have been designed as screws, without the patching and re-patching of necessity entailed on a converted ship, the principle of size seems fully carried out by the Surveyor of the Navy, and it will be seen that one and all, large or small, have now reached the length of some 300 feet; and it is furthermore evident, that, should the scheme of *revetting* ships with iron prove entirely successful in practice, ships of war will yet attain fabulous dimensions, as in the case of the experimental frigate now building at Bow Creek, whose length comes up to 380 feet.

And yet, with all these incontrovertible facts before us, the question is asked, and even repeated by some professional men, doubtless such who

* Naval Warfare with Steam. Sir H. Douglas, p. 83.

have not served of late, why we build such large ships? And we are even recommended to confine ourselves to those small two-deckers, which, as they say, did such good service in the Baltic, but which, as Sir Charles Napier observed, could neither sail nor steam.

Ships such as the "Ajax," "Blenheim," and perhaps the "Sanspareil," line-of-battle ships in name, without the power of a frigate, the worthy successors of the donkey-frigates, floating coffins of the sailing navy, and which in our coming struggles will be what the wretched 50's on two decks were in the late war,—neither able to come up to an enemy nor to run away from one, and so admirably adapted to bring disgrace upon the flag, and follow in the wake of the unfortunate "Jupiter," "Leander," "Guerrière," "Java," and "Macedonian." *

It is evident, therefore, that if there is one fact more satisfactorily established than another with the practical men of both nations, it is the one in reference to the question of bulk and form.

It has been proved beyond all doubt that rapidity of steaming is in proportion to increase of bulk, and our own and the French navy demonstrate this truism in the largest ship of every class.

The "Marlborough," "Ville de Nantes," and "Emerald," are alike remarkable for speed and handiness, and, despite their great length, a quality no longer objectionable in a ship-of-war having her motive power inherent in herself, each stays like a cutter, and turns easily in her own length; proving that, all other qualities being equal, so far as their dimensions have gone, size is favourable to velocity, and tends to economy of fuel, so much so as to make the small steamers of the paddle navy, even now, very expensive means of locomotion.

What more conclusive example can we have, when we see the noble "Renown," with her displacement of 4,890 tons, actually burning no more

* We are not sure of the author's meaning in this passage. Of the five vessels here mentioned the Jupiter only was a 50-gun ship on two decks. The force of the others mentioned, as compared with that of the vessels opposed to them, is thus given in James's Naval History:—

		Guerrière.	Constitution.
Broadside guns	No.	24	28
	lbs.	517	768
Crew (men only)	No.	244	460
Size	Tons.	1,092	1,533

		Macedonian.	United States.
Broadside guns	No.	24	28
	lbs.	528	864
Crew	No.	254	474
Size	Tons.	1,081	1,533

The comparative force of Java and Constitution was similar to that of Guerrière and Constitution, except that the Java had 100 men more than Guerrière. See vol. vi. from p. 150 to p. 194.

Leander fought Généreux for six hours:—

		Leander.	Généreux.
Broadside guns	No.	26	40
	lbs.	432	1,024
Crew	No.	282	936
Size	Tons.	1,052	1,926

See vol. ii. p. 340.—EDITOR.

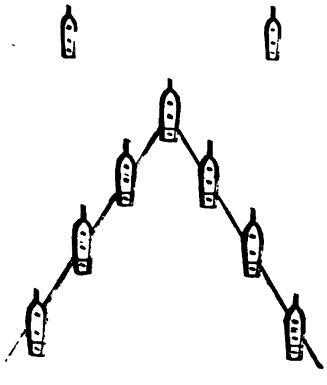
fuel to attain the same speed than the old paddle sloops of 220 horse power?

Another very remarkable application of this theory was exemplified in the passage of the fleet under Sir Charles Napier, through the Great Belt, in the first Baltic campaign, when the singular anomaly was presented of a fleet sailing in line a-head, led by the "Duke of Wellington" and "Jean d'Acre," under close-reefed topsails only, while the sluggards astern, mostly ships of the old construction, were actually obliged to spread courses, topsails, top-gallant sails, studding sails, and, in the case of the "Ajax," one of the old *forty thieves*, built in 1809, to get up steam to keep her station!

It is also true that nowhere will the change be greater than in naval tactics, for the aptitude of screw men-of-war for complex evolutions is so great, as to admit of combinations at sea similar to those hitherto practised on land. The illustrious officer of the sister service, to whom I have before alluded, and to whom the navy is so much indebted, has given us the first tangible theory yet propounded in either nation, in his admirable work on Steam Warfare, a work now well known both in England and in France, although I fear it is not so highly appreciated in the former as in the latter country, where it has excited an extraordinary sensation, and where all his suggestions are at this time in daily practice in the Toulon squadron of evolution.

Whilst scouting the idea, very prevalent with foreign officers, that steam will lessen the chances of England's supremacy at sea by enhancing the importance of military numbers, he eschews the parallel formation which has so often led to drawn battles and undecisive actions, where the enemy, if not completely beaten, boasted of a victory, as in the engagements between D'Orvillier and Lord Keppel, and the numerous other cannonades, or drawn battles, between Suffrein and Sir Edward Hughes, and he demonstrates beyond all doubt that an action gained by a steam fleet must always be attended by great results.

His own favourite formation, and one already anticipated in France, where I have seen it practised more than two years back in the squadron of evolution, the same which received the Queen at Cherbourg, is the *échellon order*, as it is called in military parlance, the *ordre endenté*, *lignes de*



relèvement, or *angles de chasses, en mouvement d'échiquier*, of the French naval code. By this arrangement, apparently the only possible one under steam, ships of war are no longer placed in the famous old line-a-head on the starboard or port tack, but in bow and quarter lines of bearing, that is, the bow and quarter of each ship face the bow and quarter of the one next to it.

We may fancy a fleet subdivided into three divisions, with the first ship of each division pointing towards the enemy, like the apex of a triangle, those astern on the port or starboard quarter forming the angles at the base. In this kind of order Van Tromp steered up the Channel in his retreat with his convoy in 1653. Admiral Cornwallis also conducted his celebrated retreat on this principle; and it was something like this that the two Admirals Moreno and Linois, when flying before the victorious Saumarez, intended to attempt, under sail; an intention baffled on every point by the vigour of the attack.

We may therefore suppose that the line of battle under steam will be analogous to the oblique order on land. Indeed, so anxious have French flag officers been on this point, that most of the manœuvres adopted as far back as 1840, in the successive squadrons of evolution, have borne some analogy to it.

Admiral Hugon more particularly attempted repeatedly to master *échellon* formations with his fleet; and his *angles de chasse en échiquier*, as they were called for the first time, were very effectually and creditably performed by his ships; but it was evident that the formation under sail would only lead to confusion before an enterprising enemy, and that a French admiral so acting would soon lose all command of his fleet, and produce the very *mêlée* he wished to avoid.

It remained for the screw to make it possible, and for Sir H. Douglas to be the first to perceive this, and to bring his experience and military science to bear upon the subject, by giving us all the combinations that *échellon* formations are capable of, and, as I had the satisfaction to tell him, he had stolen a march on all his younger contemporaries of either nation.

Let us hope that the result of the researches of this venerable officer, apparently in the full vigour of his intellect, will not, as has happened with the other improvements suggested by him, be first carried out by those who are to-day our friends, but who are straining every nerve to increase their efficiency, should we again meet as enemies.

As yet neither Admiral Freemantle nor Admiral Fanshawe have had any opportunity afforded, through the small number of ships entrusted to their commands, of carrying out any of his suggestions, and they are left in the deplorable position, through economy, clamour, fear, or what not, of confining themselves to the shifting of topsail yards, or of making, as I heard, barges simulate and play the part of line-of-battle ships and frigates. Whilst Admiral Jurien Lagravière, an officer full of zeal and enterprise for his profession, has at this present moment not a squadron, but a very respectable fleet, under his orders.

It results from such formations, to which the order of battle must now assimilate in both navies, that steam places his forces more at the disposal of a commander than formerly; but bearings may get hot at a critical time, shells may drop into the best masked engine rooms, as one did

manage to drop into the engine-room of the French liner "Charlemagne," at the naval attack on Sebastopol, and engines of the very best make by Maudslay and Penn, which answered well before, may fail at the hour of need. Nothing is more common than such failures with ships very actively employed, the troop transports for instance, and nothing can be done that will certainly avert them.

It remains still to be proved whether our noble bulwarks, our "Marlboroughs," "Renowns," "Emeralds," will stand the ordeal of the battle, or the vicissitudes of those long and dreary blockades, which were so nobly borne by their predecessors under sail; where the stowage of the ship was

PRINCIPAL DIMENSIONS of some of the most approved SHIPS of each Class in

	When Launched.	Vessel's Name.	No. of Guns.	Tonnage.	Displacement at Constructor's deep immersion.	Speed in knots per hour.	Length.			Breadth.			Depth of Hold.
							Outside all.	Between perpendiculars.	Keel for tonnage.	Extreme.	Tonnage.	Moulded.	
Three-deckers.	1855	Marlborough .	131	4000	6100	11½	286·4	245·6	205·0	61·3½	60·4½	59·6½	25·10
	1854	Bretagne . .	140	...	6850	11½	300·	269·9	...	58·6	...	...	26·3
	1859	Victoria . .	120	4126	7000	...	300·	262·2	220·10½	60·0	59·2	58·4	26·1
Two-deckers.	1857	Renown . .	91	3319	4890	12½	281·	244·3	210·	55·4	54·6	53·8	24·6
	1858	Ville de Nantes	92	...	5050	12	260·	233·11	...	53·11	...	...	23·5½
Frigates.	1856	Emerald . .	51	2913	3921	13	271·	237·	...	53·6	...	...	17·6
	1856	Impératrice .	60	...	3796	11	...	240·	...	45·6	...	...	17·6
Corvettes.	1855	Pearl . . .	21	1469	2130	10½	...	200·	...	40·4	...	...	23·1
	Not yet launched.	Barrosa . .	21	1623	...	...	252·6	225·	179·7	40·8	...	..	24·2
	1854	Duchayla . .	16	...	2968	...	...	230·	...	32·0	...	...	22·
Gun Boats.	1854	Dapper . .	2	232	...	8	...	105·	...	22·0	...	...	8·
	1859	Coudon . .	1	...	85	6	...	80·	...	16·0	...	...	7·

not, as it is now, almost sacrificed to that intricate piece of machinery the steam-engine, and its attendant fuel.

Already, and with many both in England and in France, serious misgivings exist, for with all ships below a frigate catastrophes seem more than possible: their stern-posts, engine-room being so exposed, that their safety from an enemy's fire will often depend on a turn or two of the propeller; and Sir H. Douglas may be prophetic when he writes, "that there are indications that the result of a trial *à l'outrance* may not be satisfactory."* A corresponding authority in the French service urges the same

* Naval Warfare with Steam, p. 41.

---

the ENGLISH and FRENCH NAVIES in 1860—English Admeasurement.

Draught of Water.		Constructed,		Engine,	Horse Power.		Remarks.
Forward.	Aft.	Where.	By whose Draught.	Name of Manufacturer.	Nominal.	Indicated.	
25·	27·	Portsmouth .	...	Maudslay, Sons, & Field	800	2683	Converted from a sailing ship.
...	28·	Brest . . .	Jules Marielle	Moll at Indrêt	1200	2000	Laid down and built as a screw.
..	...	Portsmouth .	Sir B. Walker	Maudslay	1000	...	Designed as a screw ship.
24·	26·	Chatham . .	Sir B. Walker	Penn & Sons	800	...	Converted from a sailing ship.
..	...	Cherbourg .	Dupuy de l'Ome	Moll at Indrêt	900	...	Designed for a screw, improved Napoleon.
18·	19·	Deptford . .	Sir B. Walker	Miller and Ravenhill	600	...	Converted from a sailing frigate.
18·	19·	Toulon . . .	Dupuy de l'Ome	At the Creuzot	800	...	Built for a screw.
16·4	19·9	Woolwich . .	Sir B. Walker	Penn & Sons	400	1324	Built as a screw.
...	...	Woolwich . .	Sir B. Walker	Watt	400	...	Now building, probably the finest ship of her class.
...	18·	L'Orient . .	...	..	400	...	Designed as a screw; a very ugly ship.
...	6½	Merchant Yard	Sir B. Walker	...	60	...	One of the most successful gun boats.
...	4·9½	Bordeaux . .	Dupouy . .	Marseilles	H.P. 20	..	New gun boat with oaken screen, very crank, mounts a rifled 48-pr. ranging 7,000 mètres.

advice almost in the same words. One consolation however we have, that while we are liable to accidents with our engines so is the enemy; and, as in the old mode of warfare, the chances remain after all pretty well equalized.

Of all the intolerable evils entailed by necessity on the screw system, it is doubtful whether the smoke nuisance does not stand paramount; rotting both sails and spars, injuring the health of the top-men, and what is greatly more pernicious still, betraying the approach of a squadron, or even a single ship, for hours sometimes before the hull heaves in sight. It is impossible to have observed at least half a dozen sail under steam without being convinced that we have here a very serious drawback. Sir Charles Napier, it is well known, when in the Baltic, was so struck with the great disadvantages of this, in a tactical point of view, that he gave it as his opinion, that on going into action with a fleet, or even with batteries, such a smoke as the Newcastle coal generates would militate against the correct performance of evolutions, and that it was a matter of great importance that a remedy should be devised either in self-consuming or otherwise.

It is true that remedies have been devised which answer well on shore, or in the peaceful hold of a yacht, but which are quite inapplicable for service, by being heavy, cumbersome, and unmanageable when the ship is rolling, and which but very partially answer the main end—that of saving fuel. One gentleman, an inventor as he styles himself, indignant at having had his invention rejected, has written a pamphlet against a late Board of Admiralty.

I have made a great many inquiries of both English and French engineers, and they are all unanimously unfavourable to his invention, indeed a single look at the elaborate contrivance must convince any man the least conversant with the requirements of a man-of-war, that, apart from its inefficiency, it is quite inapplicable for service in the navy. These remarks are not made for the purpose of discouraging a projector who has had the praiseworthy motive of trying to do away with a great evil, but, on the contrary, to stimulate him and others to renewed exertions, and to show him that its accomplishment, if it be possible, is still a desideratum in the naval service of both countries.

I now conclude, though I should have liked, had time permitted, to have prolonged my researches into the armament of both fleets; for I have a very strong suspicion, shared I know by some of the best gunnery officers of both nations, that we are altogether on a wrong tack in adopting shell guns to the present extent.

Evening Meeting.

Monday, May 30th, 1859.

Captain E. G. FISHBOURNE, R.N., C.B. in the Chair.

NAMES of MEMBERS who have joined the INSTITUTION since 18th April.

LIFE MEMBERS.

Cave, L. T. Capt. late 54th Regt.
Turnor, H., Ens. Rifle Brigade.
Vivian, Sir Robert, M.-Gen. H.M.I. Forces.
Dugmore, W. F. J., Lieut. 3rd W. I. Regt.
Speer, W. D., Capt. R. E. Midx. Mil.

ANNUAL SUBSCRIBERS.

Mainwaring, C. E., Capt. R. A.
Petrie, M., Capt. 14th Regt.
Beresford, G. R., Capt. h.p. 7th Fus.
Walwyn, J. H., Lieut. 23rd R. W. Fus.
Paxton, A. F., Lieut. h.p. 11th Huss.
MacQueen, Jas., Capt. unatt.
Downes, M. F., Lieut. R. A.
Clement, C. J., Capt. Ceylon Rifles
Hammersley, Chas. Esq. (Sen.) Army Agent
Stockenstron, Sir A. Bart., h.p. Royal Corsican Rangers
Baker, W. E., Col. Bengal E.
Dames, T. L., Capt. R.A.
Feilding, Geo., Col. ret. Beng. Army
Fox, Edwin, Lieut. H. A. Company
Forde, M., Capt. 2nd Roy. Lan. Mil.
Wadman, A. J. P., Capt. K. Drag. Gds.
Jervois, Wm., Lt.-Gen. Col. 76th Regt.
Power, W. T. J., Dep. Com.-Gen. C.B.
Burroughs, F. W., Major 93rd Highrs.
Ballin, Geo., Qua.-Mas. H. A. Company
Macphail, John, Col. h.p. 7th Huss.

LIST of MEMBERS who have paid increased SUBSCRIPTIONS.

Baker, W. E., Col. Bengal E.
Graham, L., Lt.-Col. 19th Regt.
West, Charles, Esq., late R.N.
Wadman, A. J. P., Capt. King's Drag. Gds.
MacQueen, Jas., Capt. unatt.
Napier, Gerard J., Capt. R.N.
Clement, Chas. J., Capt. Ceylon Rifles
Hammersley, Chas. Esq. (Sen.) Army Agent
Stockenstron, Sir A. Bart., Capt. h.p. Royal Corsican Rangers
Dickenson, W. Esq., Lieut. Roy. I. Vol.
Cocks, P. R., Col. h.p. R.A.
Boldero, L., Col. late Gren. Gds.
Kennedy, G. R., Col. R.A.
Paxton, A. F. Lieut. h.p. 11th Huss.
Wigram, J. R., Capt. late Cold. Gds.
Hawkins, F. K., Com. R.N.
Power, W. T. J., Dep. Com.-Gen. C.B.
Burroughs, F. W., Major 93rd Highlanders
Ballin, Geo., Qua.-Mas. H. A. Company
Rudd, H. Major ret. Bom. Army
Dixon, Manly H., Admiral
Lechmere, John, Lieut. R.N.

DONATIONS.

	£. s.		£. s.
Boileau, C. L., Major unatt. .	1 0	Blakeley, A. T. Capt. h.p. R.A. .	0 10
MacQueen, Jas., Capt. unatt. .	0 10		

PRESENTS.

LIBRARY.

Books.

Lawrence T. Cave, late Captain 54th Regiment.—The French in Africa. 8vo. London, 1859. 1 Vol. *Presented by the Author.*

Captain Spratt, R.N., C.B., F.R.S.—An Investigation of the Effect of the prevailing Wave Influence on the Nile's Deposits. Two numbers. Folio. London, 1859. *Presented by Lords Commissioners of the Admiralty.*

Report of the Committee on the Reduction of the Ordnance Maps by Photography. Small folio. London, 1859. *Presented by Secretary of State for War.*

Lamorock Flower, Esq., C.E., Lieut. 3rd Regiment Royal Surrey Militia.—Marching Out. A Manual of Surveying and Field Sketching. 12mo. London, 1859. *Presented by the Author.*

Occasional Papers of the Royal Artillery Institution. Vol. I. No. xi. April, 1859. *Presented by the Institution.*

Report of the Superintendent of the U. S. Coast Survey for 1856. *Presented by Professor A. D. Bache, Superintendent U. S. Coast Survey.*

Lieutenant H. L. Renny, Retired R.E.—On the Constants of the Barometric Formulæ. Pamph. 4to. Dublin, 1859.

On a New Barometric Formula for Mountain Heights. Pamph. 4to. Dublin, 1857. *Presented by the Author.*

The Royal Society.—Proceedings of. Vol. IX. No. 34. *Presented by the Society.*

Lieut.-General Hon. Sir E. Cust.—Annals of the Wars 1783–1795. Vol. IV. 12mo. London, 1859. *Presented by the Author.*

Samuel B. Howlett, Esq.—Directions for using Aneroid and Mercurial Barometers in determining Altitudes. Pamph. London, 1859. *Presented by the Author.*

Table of the Quantity of Rain and Snow fallen into Howard's Rain Gauge at Cobham Lodge, Cobham, Surrey, from 1825–59. *Presented by Colonel George James, R.A.*

Drawings and Engravings.

Longitudinal Section of H.M.S. "Marlborough." First Class First-Rate Line-of-Battle Ship of 131 Guns, with Screw Propeller and Auxiliary Steam Power. 2 copies. *Presented by C. L. Pickering, Esq.*

MUSEUM.

Military.

Specimens of Gunpowder used by foreign Governments—11 bottles.. *Presented by F. A. Abel, Esq., Director of the Chemical Establishment of the War Department.*

Austrian Light Infantry Musket with Consoli Percussion Lock, pattern of 1830. *Presented by Hastings Russell, Esq.*

Naval.

Model of a Steam Yacht built at Glasgow by Charles Napier and Sons for the King of Burmah. *Presented by J. G. Frith, Esq.*

Miscellaneous.

The Bust of Major-General Sir A. Wilson, Bt. K.C.B. *Presented by the Editors of the U.S. Gazette.*

The Umbo of an Anglo-Saxon Shield discovered in a Cemetery at Kemble near Cirencester. *Presented by J. Y. Akerman, Esq. Secretary of the Society of Antiquaries.*

FLEXIBLE PROPELLERS.

By James Reddie, Esq.

Member of the United Service Institution.

When I had the honour of being offered the privilege of reading a paper in this Institution, on the subject of "Flexible Propellers for Boats and other Vessels," I ventured to accept that offer while I had every reason to believe that what I should have to communicate was perfectly new, and in hope that this novelty would go far to counterbalance all imperfections in my treatment of the subject; and I also hoped to have been able, not merely to propound a theory, but to communicate the result of complete and satisfactory experiments, establishing the usefulness of the invention. In both respects, I regret to say, I have been somewhat disappointed.

To find out that they have been anticipated is I fear the too common discovery of inventors; but it is equally a fact, that scarcely any of the most important and useful inventions have been brought to anything by those who first thought of them, but the same thing has had to be "invented" over and over again, before it has been adopted, or any practical results have been attained. Hence the national and individual claims and counter-claims, as regards the invention of the steam-engine, of steam vessels, the paddle and screw propeller, and even, at the present moment, as regards super-heated steam. With respect to the paddle-wheel, we generally associate it with the names of Miller, Taylor, and Symington, or Fulton, as the original inventors, and divide the honour between Britain and America; but about 100 years before, namely, in 1690, it appears that Denis Papin first proposed to use steam to work paddle-wheels, and it is asserted in a French work that Papin in 1707 actually propelled a vessel on the Fulda by an engine invented by Savery in 1702. The first patent granted for a steam-boat in England dates in 1736, to Jonathan Hulls, exactly 50 years before the successful experiments made with Miller, Taylor, and Symington's steam-engine, which is now deposited in the Patent Museum at South Kensington. I quote these facts from an interesting paper on the paddle and screw, read by Mr. MacGregor, barrister-at-law, before the Society of Arts on 14th April, 1858. I may observe, also, that it appears from the same paper, that, long before steam was applied to move paddle-wheels, the paddle-wheels themselves were used as a motive power for vessels, turned by means of manual or other labour, so far back as 1472, that is, 200 years before Papin; and a patent for such an invention was granted in 1618 to David Ramsey and Thomas Wild Gosse; but several modern writers are of opinion that the paddle-wheel was used by the ancient Egyptians, though Mr. MacGregor thinks this cannot be properly substantiated.

Few people, unless those who have given special attention to the subject, will be prepared to find, that what we generally consider the quite modern screw propeller is an old invention. The first name mentioned by Mr. MacGregor is again a Frenchman, — Duquet, who, in 1729, 50 years after

Papin's steam paddle-wheel, submerged an apparatus for propelling like a smoke-jack or windmill; and in 1746 Bouguer relates, that revolving vanes, like those of a windmill, had been tried for the propulsion of vessels. But it appears, besides, that in China the screw propeller is of indefinite antiquity. In 1780 a model of one was brought from that country. The first distinct description on record, however, of a screw propeller is that of D. Bernouilli, of Groningen, in 1752, which, it seems, was sufficiently matured to comprise the use of oblique vanes at the bow, sides, and stern, turned by a steam-engine, and capable of being hoisted out of the water. Mr. MacGregor (p. 4) adds, "In 1768, Paucton proposed the pterophore, or screw thread on a cylinder, to be wholly or partly immersed. In 1770 James Watt suggested to Dr. Small the trial of a steam screw-propeller. Bramah in 1785 first patented a rotatory engine for this purpose; Ramsey (1792) put the screw between two hulls; and Lyttleton (1794) used a three-threaded screw; while Fulton (1798) tried one with four blades. Shorter's screw (1800), with a jointed shaft, and worked by men, was applied in 1802 to H. M. ships Dragon and Superb. The first screw steamer was tried by Stevens in America in 1804. In 1825 Brown used one on the Thames."

In art or science, or indeed any other human pursuit, it is scarcely ever wise to suppose we have arrived at perfection; and, before I quit the subject of the screw propeller, perhaps I may be allowed to state that within the last few weeks I have had an opportunity, through the kindness of a gentleman well-known in this place as the promoter of all that tends to scientific advancement in respect of ships and vessels—I mean Captain Fishbourne—of witnessing a series of interesting and important experiments with a new screw propeller invented by Mr. Soëlman, and which seems to possess many decided advantages over the ordinary screw propellers now in use. Strictly speaking, this new propeller is not a screw, —the blades not being twisted like the sections of a screw, but simply flat blades placed obliquely on their shaft, but of a peculiar shape, broader at the base than is usual, and, as a rule founded upon a proper theory, with the extreme corners cut off, and one corner of each blade more or less bent. With blades of this construction, which have this advantage, that they admit of being made of wrought instead of cast metal, Mr. Soëlman finds he obtains greater speed with four blades, like Fulton's screw, than with two, contrary to experience with screws of the ordinary shape. I cannot, however, dwell longer upon this subject, but I may be allowed to add that it was stated in to-day's "Times" that the screw of the Doris, one of H.M. ships, has had its leading corners cut off, with increased speed as the result, and that further experiments are to be tried with both corners cut off.

After these allusions to the well-known paddle and screw propellers, the efficiency of both of which for marine propulsion is so well established, it requires some degree of boldness to call public attention to another class of propellers totally different. When, however, it is considered that from 1618, when the first patent was granted to Ramsey for his paddle propeller, to June 1857, no less than 803 English patents relating to marine propulsion have been sought or granted, it is not to be imagined that all these inventions relate to paddles and screws alone. Without doubt the great majority of them are adaptations of these two; and after these, the most

numerous class consists of collapsing propellers of various kinds, in imitation of ducks' feet, sometimes adapted to be used as oars, sometimes as paddle-floats, and some even as screws. These propellers are called duck's-foot, swan's-foot, hinged, jointed, collapsing, &c. and frequently compared to the opening and shutting of the leaves of a book. They are all, however, obviously imitations of the motion of aquatic birds; and I confess I see nothing in the particular operation of nature which they attempt to follow, to promise great results, even could art and science entirely come up to nature, as we know it never does. Few things certainly are more beautiful than the "majestic swan," especially when, its feathers distended, it sails before the wind; but it, as certainly, is not a fast sailer; and when it makes most haste, and relies most upon its collapsing propellers for its progress, its motion is far from steady, or even graceful. The jerky speed it then attains is neither very great, nor worthy of being imitated. It is difficult to understand, therefore, why so much time and money and ingenuity have been wasted upon this particular kind of flexible or collapsing propellers. They seem to me, besides, objectionable for this additional reason, that, of necessity, they are not continuous in the propulsive force they exercise, and every one knows that continuity of force or pressure is the grand essential to produce velocity. This is peculiarly exemplified in the operation of the screw: its first few turns produce little or no effect, but motion once produced, slight increments of force continuously operate and add to the previous velocity, till a maximum of speed is attained, which has only a limit because at a certain speed the obstruction of dragging the screw itself through the water balances its propulsive power, which, again, cannot be increased by making the revolutions of the screw more rapid, because then it would cut through the water, and its "slip" become fatal to its progress.

It is, then, with a full appreciation of the truth and importance of these principles, which govern propulsive power, that I venture to bring under your consideration another propeller, different from any of those yet mentioned. It, too, is borrowed from nature; and, as the problem is how best to produce a motive power in water, it must surely be admitted that we go to a legitimate source, when we set aquatic birds and even amphibious animals aside, when we neither attempt to copy from the swan, the beaver, or the frog, but go direct to the fish. Here, indeed, if art and science will enable us to attain but approximate results, we shall have all we can desire. Every one knows the grace and ease, and marvellous rapidity, at times, with which the finny tribes move in their native element. When they make a dart, it almost seems as if it were a mere exercise of will, (as when one waves his arm,) without the necessity for propulsive power obtained by mechanical means, *ab extra*, from pressure against the water. But it is not so. The fish cannot move an inch by mere will. It is, as it were, in a state of equilibrium in the water. By its volition it can move its fins and tail—parts of itself; but all the motions of its whole body, from place to place, are merely mechanical results, the effects of pressure and resistance, produced by the action of the admirable instruments nature has endowed it with. The fish is as truly propelled by the action of a material propeller as a paddle-wheel or screw steamer. All that, by its volition, life and instinct, the fish accomplishes, is merely

analogous to the motive power of the steam-engine inside a vessel, while the paddle-wheel or screw, acting upon the water, does what is accomplished by the fins and tail of the fish, or, more strictly speaking, by its tail alone. We know the results. Nature beats art: and from this point of view the question naturally arises, why have flexible propellers, in imitation of fishes' tails, not been tried, before paddle-wheels and screw propellers were thought of? The fact remains, unquestionably, that the most rapid motion of a fish is produced simply and merely by the vibratory motion of its tail, and the continuous pressure thus exerted against the water; and the *onus* seems, therefore, thrown upon the inventors of propellers, to explain why they have so generally disregarded this most common example of nature. Surely the first propeller ever tried ought to have been a flexible, or fish tail propeller; and to a certain extent, perhaps, this has been the case; for what is the paddle of the Indian but a rude imitation of the action of a fish's tail, only with a very imperfect instrument? Amongst ourselves, a single oar is frequently seen, adroitly manipulated with the figure eight movement called sculling, and many inventions have been tried to produce the same results by machinery. So far back as 1745 Masson describes an apparatus for this purpose.* A patent for a similar invention was granted to W. Taylor and H. Davies in 1836;† another in 1840 to William Mill;‡ and another so recently as 1847 to Jean Charles Victor Coullon.§ From the description of these patents, as one might have anticipated, the machinery is necessarily very complicated to produce so complicated a motion; and, after all, there is the same objection to them that was urged against the collapsing propellers, namely, the want of continuity in the pressure they produce, and the consequent loss of time between each effective stroke of the blade or paddle. Few attempts have, however, been made to follow nature—always perfect in its simplicity, and simple in its perfection—with greater closeness. Very few seem ever to have thought that by means of a flexible paddle the same, or rather a greater, effect would be produced than by sculling with a rigid blade, and that without the necessity for any such complicated movement. I say, few seem to have thought of this; and, for a whole month after the idea first occurred to myself, I was led to believe that there was no trace whatever of any patent for or other record of such an invention.‖

Do not suppose for a moment that I intend to inflict upon you the records

* Abridg. of Specif. of Patents for Mar. Propul. vol. i. p. 25.

† Ib. vol. ii. p. 126. ‡ Ib. p. 156. § Ib. p. 206.

‖ A short notice of this paper having appeared in the Mechanics' Magazine of June 10, 1859, Captain Selwyn, R.N. wrote to the editor on the subject (*vide* Mec. Mag. 1 July, 1859), to the effect that it is "scarcely correct to assume that the 'fish-tail' form of propeller has been so much overlooked," and referred to the new edition of Tredgold's work, Appendix D. As to this I can only say I have noticed every instance in the Abridgment of Specifications, and indeed the fact that, except in the last edition of Tredgold's work, such propellers are not noticed at all, shows how very little attention has been given to this kind of propeller. Captain Selwyn also proposes a very ingenious mode of combining the screw and fish-tail, as to which reference is made to his interesting letter and the diagram which accompanies it; but I fear such a compound propeller would be still more liable to "foul" than a screw by itself, and could not be afterwards cleared without still greater difficulty.—J. R.

of a grievance. It is true I invested some ten pounds in securing provisional protection from the Commissioners of Patents for what I had then every reason to believe was really a new invention; but I never, from the first moment, arrogated to myself any merit in the matter, for I always regarded it as by a mere accident, which, indeed it was, that I had been led to think of it. I have, also, a most wholesome dread of an observation of Mr. Scott Russell's (made at the meeting of the Society of Arts at which the interesting paper from which I have quoted was read by Mr. MacGregor), "that the faculty of mechanical invention was not a very unusual faculty; that it belonged to nearly everybody, and that it was one of the greatest misfortunes that could fall upon a man when he took it into his head that he was endowed with a larger portion of that faculty than any one else." (p. 7.) I certainly do not go quite so far as Mr. Russell, when he adds, that "there were men in this country who could invent anything they were asked for, and all we had to do was to pay them for inventing." (p. 7.) This is surely decrying one's own art, and is a somewhat too mercenary view, if I may so say, of the motive power of the inventive faculty; still, every one will admit, that it is not to be expected that every private individual can afford to make expensive experiments, in order to mature some invention, without a reasonable hope of some return. But, in truth, instead of inventors being such mercenary beings, they are rather too much given to ride their hobby at all hazards, and so get involved in difficulties; and many a caution I have received from those experienced in such matters, "not to be too sanguine;" "not to incur much expense;" and even "not to ruin myself," in trying to carry out my invention. I am not likely to do so; in fact, I cannot afford it. If a reference to the Index of the "Abridgment of the Specifications of Patents relating to Marine Propulsion,"—an epitome of information most justly praised by Mr. MacGregor as a means for preventing ingenuity, time, energy, and private expenditure being needlessly thrown away by inventors discovering over again what had been already invented,—did not enable me, or the patent agents I employed, Messrs. Newton, of Chancery Lane, to discover that I had been forestalled; yet, by reading through the Abridgment itself, I discovered that such was the fact, in very good time, before my expenditure had been excessive; so my grievance is a comparatively slight one. I do not wish here to raise any question as to the propriety of granting "protection" when it is doubtful whether a patent could be maintained; and, at any rate, there is this to counterbalance any disadvantage I labour under in thus confessing my invention is not quite new, that I am no longer the mere exponent of my own views, but am able to place self aside, and speak in favour of the flexible propeller on more independent grounds.

It is a somewhat curious circumstance that the only propellers in the "Abridgment of Specifications" which are called "fish-tail" propellers, are indexed under the title "Propeller, Screw." The first is in 1841, to William Joest, called "the double fishes'-tail," "composed of a prismatical hollow solid," which is a "bent vane on a vertical axis, and which *revolves* under water" (p. 162). It will be admitted that no revolving propeller can be considered as having any resemblance to the action of a fish's tail. The next (also in 1841) is to John G. T. Campbell, and is called "a

whale-tail or fluke propeller." It is thus described in the Abridgment (vol. ii. p. 164):—"Two flap-like vanes, swinging fore and aft on horizontal axes, are so moved under water in an aperture through the dead-wood at a vessel's stern, as to imitate the motion of the tail of a fish, when the broad surface is nearly vertical and across the direction of the fish's length. This is done by an arrangement of levers and jointed 'knuckles,' the action of which is explained by the drawings."

This, it will be observed, is also rather complicated, and scarcely the fish-tail *au naturel*.

But, leaving the Index, and proceeding to the text of the Abridgment, at p. 16 we find that in 1683 Borelli of Rome describes a submarine vessel, "navis urinatoria," which he had invented, to move by fins or collapsing oars; but he adds that, instead of these, probably an easier mode of propulsion would be by one flexible oar acting like a fish's tail.

The next trace to be found in the Abridgment is at p. 61, Patent No. 3,909, 25 April, 1815, to Sam. J. Pauly and Durs Egg, for an aerial machine with feathery wings; to which is added, somewhat vaguely, "2. The patentees declare that the same principle is also applicable to the propelling of vessels through the water." I think we need not be surprised if this vague claim was not considered a proposition for a fish-tail propeller, or indexed as such. Neither would it be supposed by many that it was practicable either to move balloons by means of imitative fish-tails, or boats with imitative wings. And yet, upon reading these inventors' full specification in the Patent Office, I was astounded to find that, with this mere hint of such a possibility, he claimed such a universality of patent right, to apply to vessels, wings, feathers, fins, fans, and even tails, that I brought away with me a copy of his specification as a curiosity, and I beg to be allowed to read an extract from it, alike as an encouragement and warning to all inventors:

[*An extract from the Specification was here read.*]

It must be remembered that this sweeping privilege was granted; and certainly nothing can be easier than to be an inventor and obtain patent rights in this exclusive style, if only first in the field, and nothing more difficult, on the other hand, than to become an inventor and patent an improvement, if such exhaustive previous claims are meant to be sanctioned.

I may state that having often observed that percussion caps were stamped D. EGG, and remembering the same letters on fire-arms and the window-sill of a shop in the Opera Colonade, I was induced to call there and inquire whether anything was known of Durs Egg, the inventor of this flying balloon, and of the invention itself? I found that he was an ancestor (father or grandfather) of the present Mr. Egg, gun-manufacturer, and that the balloon in question, which cost a great deal of money, was sold for a song at the death of Durs Egg, the inventor. So far as I could learn, it had not been attempted by him to apply it to vessels in water, notwithstanding the terms of the patent.

The next propeller of the kind is patented by James Dawson, 14 March, 1816, No. 3,996, only a year after, and notwithstanding the sweeping patent last mentioned. It is in the first place, and chiefly, for a rotating flexible propeller, and only, as it were, by-the-bye, for what I conceive to be the most valuable invention, a vibrating fish-tail propeller. In the

Abridgment it is merely described as "A paddle or screw propeller of elastic rods, covered with fan-like elastic pieces of canvas or similar material;" but upon obtaining the specification itself from the Patent Office, I found that it was veritably a fish-tail propeller, such as I imagined I had been the first to think of. We shall revert to Dawson's invention bye and bye; in the meantime I will shortly allude to the two only other inventions of the kind which appear in the Abridgment. In 1824, Nov. 11 (No. 5,053), p. 78, William Busk obtains a patent for "An elastic plate fixed to an axis at one end, which is caused to vibrate back and forward in the water. The axis may be horizontal or vertical." And so late as 1854 (June 2, No. 1,224), p. 263, the Earl of Aldborough patented "a vessel propelled by wing-like sails, urged by springs in conjunction with vacuum chambers and numerous other contrivances described at length; and in another form the propulsion is effected by an elastic propeller, acting in some manner like a rudder, and with or without valves, not particularly explained." He refers to a previous patent (1854, No. 224,) referring only to aerial locomotion, and I have therefore not thought it necessary to procure the specification of this invention.

Dawson may in fact be said to be the only person who has anticipated the invention, the claims of which to your consideration I venture to speak of. He patents three inventions: 1st. elastic floats for paddle-wheels; 2nd. elastic masts and sails; and 3rd. (with which we have to do,) an elastic lever or oar, with one end formed somewhat in imitation of the tail of a fish.

[*The Specification was here read.*]

I confess I do not understand what advantage he expects to gain either by the elastic plane, which he states he *sometimes* attaches to the handle, nor why he proposes that the handle, lever, or oar itself should be flexible like the backbone of a fish, with a vertebral action. The vertebræ of a fish are used to bend the body of the fish itself, and they have an elasticity and spring which no doubt greatly facilitates the various curvelinear motions of the fish in the water, but for a mere onward movement they are not required; and if a lever or rod to which an imitation fish-tail is attached were jointed and rendered elastic in this manner, it would only weaken its power for causing the tail part, in the water, to vibrate to and fro with sufficient force against the water's resistance. This being the case, I doubt very much whether Dawson ever made any experiments with such an elastic oar.

As regards the moving of his flexible propeller, Busk seems to have had a more practical view than Dawson. Busk's propeller is simply an elastic steel plate, which he proposes to attach to vessels like a rudder, and work it from side to side either with a tiller by the hand, or with the aid of machinery, without any complicated details for obtaining a closer imitation of the power of a fish's tail. Any one can at once perceive that to move such a propeller in the water an elastic or bending tiller would not give the helmsman greater power, but the reverse.

[*Busk's Specification was also read.*]

Let us now inquire what distinct advantages this mode of propulsion seems to promise, and what difficulties are to be overcome in attaining them.

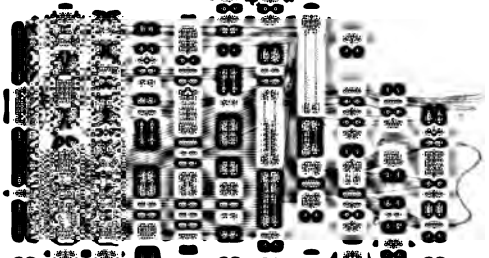
In the first place, I suppose it may be assumed, that the moving from side to side of a flexible paddle, or rudder, at the stern of a vessel, will propel the vessel. But not only so: this motion of a flexible propeller will be found to have little or no retarding influences to overcome; its every action is propulsive, partially, no doubt, (like the oar in sculling, or the screw propeller,) in an oblique direction, but also in a great degree directly in the direction of the vessel's onward motion. In the next place, from the position of such a propeller, submerged at the stern of the vessel, with the centre of the propulsive force level with the centre of gravity, the stable equilibrium of the vessel is not disturbed, and there is no waste of power, such as there is in sculling, which pulls the boat down against the water as well as onward; and as there also is in the paddle-wheel, unless when made to feather by complicated machinery; and as there is even in rowing, the action of the oars being chiefly oblique, except at the moment when at right angles to the boat, while even then a great part of the pressure tends to pull the boat downwards to the water, as may be observed by watching the rise and fall of a boat between each stroke of the rowers.

Before extending the comparison further to the screw, I would beg to point to some special advantages such propellers would have for boats. By means of crank machinery and multiplying power, I venture to anticipate that one or two men might do in a boat, to which steam machinery could not be applied, as much as is now accomplished by eight or ten rowers. Boats so propelled could also move up creeks and narrow rivers, where oars could not be used; and, for war purposes, it must be manifest that a boat with a crew of riflemen must be far more formidable than one encumbered and chiefly filled with a dozen rowers, with their backs exposed to the fire of the enemy. Such propellers could also be used in boats in aid of sails, which oars can scarcely conveniently be, both on account of the position of the rowers, and also the jerky and unsteady motion of rowing.

It was, indeed, almost solely as a substitute for oars that, in the first instance, I considered the fish-tail, or flexible propeller, would be found useful; and it has only been as such that I have as yet made any experiments. I had no models made. As the operation of such a propeller is very simple, I resolved, from the moment the idea struck me, to have one fitted to a boat, and prove the value of the invention by coming down the river. I have already expressed my regret that I had not been able to realize that idea. And, indeed, after I discovered that Dawson and Busk had anticipated the invention, I shrunk from appearing here this evening, with no very practical results to communicate. But the fact that these anticipations may probably prevent my laying any exclusive claim to the invention is, on the other hand, one of the most cogent reasons for making it more generally public, that others who have more time and money, and greater mechanical skill, may be induced, if so disposed, to undertake the task—which I think would be a most interesting one—of working it out to a practical result.

Those who are fortunate, or unfortunate, enough, as it often happens, to be inventors, have generally a difficulty as to the construction of their models, or mechanical contrivances. To whom to apply to make a fish-

bwever, I did not
. fan or tail made,
out this propeller
nal pieces of gutta
for inserting ribs
th. (*Vide* figure.)

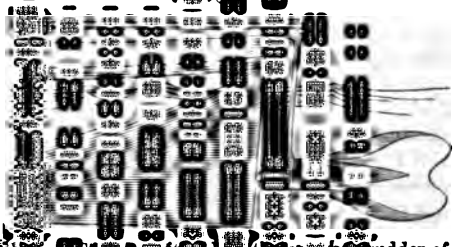


.B.
em.
rcha.

feet, greatest width
pered down to an
rigid with wood, I
, and the propeller
confess when I saw
ghtness of my pro-
Notwithstanding
ade, which was not
action, this slight,
at a strong tide and
also a considerable
ream; but the boat
the propeller being
al. This boat was
rn-post, or, rather,
ow and stern being
the propeller being
of one of its special
feet from side to
almost altogether.
y limited vibratory
rial; for, contrary
ement of this kind,
ower, while I had
at each turn of the

aching the propeller
, of course, the ob-
in the water was

er formed, (fig. 2) with
fitting any boat, and of



udder of the boat.

g with a vertical stern-
e propeller was moved
perienced. There was
ich allowed too much
the boatman being ex-
his gig, I was induced,
the pintle, to shift the
d also a nearly upright
most have propelled a
ught my experiments to
d given way, and I was
ay, extremely chagrined,
ccident of this kind, it
in perfecting the screw

new propeller, or rather
gth and flexibility; but
ndulgence you are so
ails of the delays and
meantime I made the
t after all it was very
coming every difficulty,
consideration, however,
have said, I do not quite
notive power, though I
uced some caution as to
ness engagements came
d with one of the civil
ative demands upon my
tterly unable to attempt

. Formidable—who takes an
ribs, separated at the stern-
's tail, the "flabby" part of
as, and experiments are now

One word as to the application of flexible propellers to larger vessels, to be moved by steam machinery. Can it be expected that they would have advantages over the screw? In the first place, even if such a propeller were only a simple elastic steel plate, without any other contrivance to obtain the many wonderful powers of the fish's tail, its action would probably equal the screw in efficiency for ordinary speed; but, besides that, it promises almost an indefinite increase of velocity by means of more rapid vibrations, as it will have no slip, and presents no opposing surface, like the blades of the screw, to be dragged against the water. For the same reason, it will be a more efficient auxiliary to sails than the screw propeller can ever be; and, when not used as an auxiliary, it will not, like the screw, obstruct the course of the vessel when moving under sail alone. These appear to me to be no slight advantages, and they might, of themselves, well induce those who could afford it, who are interested in the progress of scientific navigation, at least to make experiments. I need scarcely add, that such propellers are at once propellers and rudders, and that the steering power of a vessel so propelled will be immense, and may be employed to turn a vessel when at rest, as one sweep of the propeller would put way on the vessel at once, and, if not reversed, would move the vessel to one side. It is obvious, however, that in all that has been said of this propeller, no means for going astern has been provided. That is quite true; but the point has not been overlooked, though it would add inconveniently to the length of this paper to deal completely with the subject now. I will, therefore, only observe that it is of secondary importance, compared with increased speed forwards, and that, even without any appliances for backing, the greater ease in turning a vessel with a flexible propeller, will, in a great measure, of itself counterbalance any such disadvantage.

But to conclude. It is a most natural question to ask, Can we hope, by artificial means, to attain, even approximately, so complete a propulsive instrument as nature has supplied to the fish, and thus rival its wonderful rapidity? I do not for a moment suppose that we ever could obtain a power like that of the salmon, by which it performs the most extraordinary feats, both in darting and leaping; but, for a steady, rapid, onward motion, we have every reason to expect we can. We cannot hope to rival the marvellous combination of flexibility and strength we find in the salmon's tail; but, if in that nature has the advantage, on the other hand it will be found that, in some respects, for such a propeller, science has the advantage even over nature. I trust this observation will not be misunderstood. Nature and true science are never antagonistic. I was alluding to the power of the steam-engine, by which our inferior propellers could be driven to and fro in the water, with a force and rapidity, and unflagging continuance, that not even the strongest and swiftest fish could ever exert. In this, science would have an advantage, which would compensate, and probably more than equal, the disadvantages of our inability to come up to the marvellous mechanism of nature in the construction of the fish's tail. And this is no foolish boast; for what is that science which accomplishes such results? It is merely the application by man, "as the minister and interpreter of nature" (as our greatest philosopher designates him), of other powers of nature, fulfilling the will of the Omnipotent. It is thus that

"knowledge is power." It is not art alone that drives the steam-engine; it is the expansive power of heat acting upon water, directed through man's knowledge and art, to do his will, but the power so potently exerted is after all a simple power of nature. And so with the still more powerful agency, which is frequently under the consideration of those connected with this Institution, and which, as we now speak, is carrying death and destruction elsewhere, and even thus affecting the present and future fate of nations. It is not art alone by which the ball from an Armstrong gun parts from its muzzle like a thunderbolt, and shatters all that would resist it: it is only art, after all, using and directing one of nature's most mighty agencies; and, in short, it should never be forgotten that, in all science, nature's power must be predominant, and that it is man's most legitimate province to render all the powers of nature subservient to his use by means of knowledge and art. True science ever and only exhibits the marvellous powers of nature, combined with art and skill, in harmonious co-operation.

Mr. MacGregor.—With respect to the question of the fish-tail propeller, it is very difficult to speak of it unless one is in a boat in which it is tried: I think it is a mistake to compare it to any other mechanical arrangement for a similar purpose. Its action is of an exceedingly complicated kind; but I would give a word of encouragement to Mr. Reddie, not to be disheartened because others have been in the field before him. I must say that if they are able to give us as intelligent an account of their inventions as he has of his, they will produce significant results.

Chairman.—The subject is a very important one, since we all know or have experienced how numerous are the accidents which occur to the screw, and that, in some cases, there are no results commensurate to the enormous powers used. There is another disadvantage in the screw, viz., that it is scarcely applicable to light-draught vessels; yet we are going very much in the direction of light draught. Such vessels will be immediately necessary for the defence of our coasts in case of attack; and there is scarcely any part of the world where light vessels with such a propeller as this would not be of very great utility. We saw during the late operations at Canton that, while every one of our screw vessels broke down, an old paddle-wheel steamer, doing ten times the work, remained serviceable to the last. Mr. Reddie has read a very interesting paper, exceedingly well reasoned out, and it cannot fail to afford considerable instruction, especially to those experimenting on any similar contrivance. I must, therefore, return him our best thanks for his very interesting paper.

Mr. Austin exhibited and explained an apparatus of his invention for raising vessels sunk in deep water.

The Journal

OF THE

Royal United Service Institution.

VOL. III. 1860. APPENDIX.

PROCEEDINGS OF THE TWENTY-NINTH ANNIVERSARY MEETING.

A GENERAL MEETING of the Members of the ROYAL UNITED SERVICE INSTITUTION was held in the Lecture Theatre of the Institution, Whitehall Yard, at Two o'clock P.M. on Saturday the 3rd of March, being the Twenty-ninth Anniversary Meeting.

The Right Hon. the EARL DE GREY and RIPON, Under-Secretary of State for War, in the Chair.

I. The Proceedings of the last Anniversary Meeting were read.

II. The CHAIRMAN said—

It now becomes my pleasing duty to lay upon the table the Royal Charter of this Institution. I am confident that I speak the sense of all present in congratulating you upon the fortunate circumstance, that this Institution, so valuable as I believe it to be to the united services of the Army and the Navy, has received this mark of Her Majesty's approval. That approval will be appreciated nowhere more highly than among the members of these two services; and I rejoice to think that by thus placing—if I may so say—her high seal upon this Institution, Her Majesty has been pleased to signify that she approves of the efforts which you are making for the spread of scientific knowledge, for affording opportunities of information to the members of both those services, upon whom Her Majesty, in times of danger, will be able for the future, as she has in the past, always to rely with certainty. I will now call upon the Secretary to read the Annual Report.

III. The Annual Report of the COUNCIL was read as follows:—

1. In submitting the Twenty-Ninth Annual Report of their Proceedings; the COUNCIL have the satisfaction of announcing that Her Majesty has been graciously pleased to grant a Charter of Incorporation to the Members, and that the United Service Institution commences the Thirtieth year of its existence as one of the established Royal Societies of the Country. The COUNCIL confidently call the attention of the Members to the steady and decided progress which the ROYAL UNITED SERVICE INSTITUTION exhibits in all its departments; and, though there is no doubt room for still further improvement in organisation, yet its design has been considerably developed during the past year, and its efficiency materially promoted.

2. It has been the earnest desire of the COUNCIL, to conduct the affairs of the Institution in such a manner as to make it of practical utility to the Members, and worthy of their support. The COUNCIL are satisfied that their exertions in this respect have to a great extent succeeded, and that the reputation of the Institution has increased in the estimation of the professions.

3. Although much has been done within the last three years in extending the resources of the Institution and enlarging its sphere of action, much still remains to be accomplished. The expense both attending, and consequent upon, the alterations which have been carried out has been great, and the COUNCIL have other improvements in contemplation, which they believe will augment the efficiency of the Institution, whenever its financial condition will admit of their being proposed. They therefore again express their great anxiety to obtain the cordial co-operation of Officers of rank and influence, the value of whose moral support cannot be too highly appreciated.

THE MEMBERS.

4. The increasing disposition to join the Institution which was displayed in 1858, and which the COUNCIL noticed with so much pleasure in their last Report, continued during the past year. The number who enrolled themselves as Members in the year ending 31st December, 1859, is 195. The loss which has been sustained by death amounts to 84; the withdrawals to 13; the increase upon the year is therefore 98. A detailed statement of the changes among the Members, and the Tabular Analysis, appear in page xxvi.

FINANCE.

5. The COUNCIL now submit the General Abstract of the Accounts for the year 1859, as audited on the 16th of February, 1860 (see opposite page).

Receipts.

6. The ordinary receipts have exceeded the amount estimated by £140. Liberal donations have further augmented the income of the year by £113

GENERAL ABSTRACT OF THE ACCOUNTS OF THE UNITED SERVICE INSTITUTION

FROM 1ST JANUARY TO 31ST DECEMBER, 1859.

EXPENDITURE.	Amount. £	s.	d.
Secretary's Salary	150	0	0
Clerk's do.	72	0	0
Servants' Wages	302	15	6
Do. Clothing	36	8	0
Fuel	36	4	0
Lighting	20	3	6
Postage	64	11	6
Fire Insurance	29	5	0
Library	84	0	7
Journals	690	18	4
Advertisements	29	2	6
Artificers, Carpenters, Ironmongers, Painters, Glaziers, &c.	151	10	3
Stationery, Printing, Circulars, Tickets, &c.	101	0	8
Lectures	17	9	4
Income Tax for Clerk and Porter	5	1	6
Parish Rates	90	12	6
Water do.	10	0	0
Assessed Taxes	92	16	7
Ground Rent	197	16	0
Catalogues of 1849	26	18	0
Domestic Sundries	10	12	3
Miscellaneous	52	14	10
Annuity to Malcolm	20	0	0
Stamps	0	9	1
Total Expenditure	£2,292	9	11
Cash repaid to Agents	4	0	0
Invested in purchase of Consols at 97¼	495	1	2
Balance at Bankers 31st December, 1859	46	1	1
Total	£2,837	12	2

RECEIPTS.	£	s.	d.	Amount. £	s.	d.
Balance at Bankers 31st December, 1858				48	11	2
Annual Subscriptions at 10s. for 1859	1,109	5	0			
Do. do. above	331	13	0			
Do. do. arrears	50	0	6			
Do. do. advance	35	10	0			
				1,526	8	6
Entrance Fees				195	0	0
Donations				113	14	0
Grant from Government				400	0	0
Life Subscriptions				512	0	0
Dividends				12	17	6
Sale of Old Cases				4	0	0
Sale of Journals				25	1	0
Total				£2,837	12	2

London, 16th February, 1860.

Examined and found correct, THO. SMITH. J. E. A. DOLBY. } Auditors.

(see page xxvii.). Two hundred and eighty-four Members have increased their Annual Subscriptions from Ten Shillings to One Pound during the past year, making a total increase above the estimate of £395. The subject of increased subscriptions will require special explanation in commenting upon the Journal.

Expenditure.

7. The expenses of the year have exceeded the estimate by £340. The improvement in the receipts enabled the COUNCIL to augment the expenditure upon those branches which have contributed so largely to enhance the reputation of the Institution, and extend its sphere of utility; the excess being chiefly owing to a general increase of business, and the enlarged circulation of the Journal. The following are the principal items:—Pension of £20 granted to the senior Porter for age and length of service; Postage £24, entirely owing to the transmission of the Journal; Library £14, partially consequent upon the progress of the Topographical Department; Printing and Stationery £51, caused by increase of business, the Special General Meeting, and also by the great demand for tickets of admission to the Lectures, Museum, &c. amounting to upwards of 30,000; The Journal £190, it having become necessary to raise the numbers printed from 2,000 to 3,500, for the reasons hereafter explained; Miscellaneous £52 (no estimate was made under this head), the items being chiefly the carriage of donations of Foreign Governments, the purchase of Models, and expenses connected with the Museum.

8. The COUNCIL have the satisfaction of informing the Members that they have invested in the purchase of Stock the Life Subscriptions received during the past year, and also the sums received from Life Members in augmentation of their original Life Subscription, amounting together to £490. The funded property of the Institution is therefore £946. 11*s.* 8*d.* Three per cent. Consols.

9. In submitting the estimate of the ordinary receipts and expenditure for the year 1860, the COUNCIL find, that the resources upon which they can now rely, enable them to make a closer estimate of the necessary expenditure than they have been able to present upon recent occasions. At the same time the business of the Institution is not yet in such a state of complete arrangement as to permit them to reckon with certainty upon the expense which, if the income admits, it might be advisable to incur; alterations have yet to be completed in the Museum; and the expense of the Journal, as far as it depends upon the numbers issued, cannot yet be accurately estimated. The Institution, however, commences the year with upwards of 800 subscribers at one pound per annum, of whom 383 have increased their subscription since the 1st of January, 1860, and this enables the COUNCIL to propose the following estimate:—

10. ESTIMATE OF PROBABLE RECEIPT AND EXPENDITURE FOR 1860.

EXPENDITURE.	AMOUNT. £	s.	d.
Secretary's Salary	150	0	0
Clerk's Salary	72	0	0
Servants' Wages	350	0	0
Ditto Clothing	57	0	0
Rent, Taxes, Rates	400	0	0
Fire Insurance	29	5	0
Fuel	45	0	0
Lighting	22	0	0
Library	100	0	0
Lectures	20	0	0
Journals	500	0	0
Annual Report	50	0	0
Printing and Stationery	100	0	0
Advertisements	40	0	0
Postage	70	0	0
Artificers, Casualties, &c.	100	0	0
Repairing and Painting Building	55	0	0
Domestic Sundries	20	0	0
Miscellaneous	50	0	0
Reprint of early Journals	60	0	0
Malcolm's Pension	20	0	0
Balance	119	15	0
Total	£2430	0	0

RECEIPT.	AMOUNT. £	s.	d.
Annual Subscriptions:			
At 10s.	840	0	0
At £1 and upwards	960	0	0
Entrance Fees	200	0	0
Dividends	30	0	0
	£2030	0	0
Parliamentary Grant	400	0	0
	£2430	0	0
Total	£2430	0	0

11. The COUNCIL call the attention of the Members to some alterations which appear in the above estimate. The business conducted in the Secretary's office, and in the Museum, has increased to such an immense extent that the present staff are inadequate to the efficient discharge of the duty required of them. The frequent communications with the Members which have now become necessary give almost constant employment to an extra clerk, while the articles in the Museum require greater supervision than can now be afforded. The COUNCIL have therefore increased the item for wages by £50. It is necessary to repair and paint the part of the premises in Scotland Yard, the expense of which will be about £55. A sum of £60 is also estimated for reprinting the early Numbers of the Journal, which will be hereafter explained.

THE JOURNAL.

12. The anticipations which the COUNCIL entertained when they commenced the publication of the Journal have been realised to a most gratifying extent. They have succeeded in issuing an instructive professional periodical, which has received the cordial approbation of the Members. It has become a source of interest to Officers who are serving abroad, and maintains a connection between them and the Institution; it has also proved an inducement to Officers of both professions to give the Institution their support.

The COUNCIL have frequently received communications from Officers on foreign stations, expressing their high appreciation of its merits.

13. The COUNCIL had estimated that an issue of two thousand numbers would suffice, but, as soon as the character of the Journal became known, its popularity was evinced by the re-appearance of a considerable number of Members, who had not for years taken any interest in the affairs of the Institution, whose addresses were even unknown, and who now preferred their claim to the numbers of the Journal. The result is, that the copies printed have increased to 3,500, and the COUNCIL have found it necessary to reprint the early numbers to meet the unexpected demand. The Members will readily comprehend the additional business entailed upon the staff of the Institution, and the extra expense incurred in printing, postage, and clerks.

14. The COUNCIL have hitherto carried out the intention they announced in the Report of 1858, of issuing and forwarding the Journal to the Members free of charge, a system which they proposed should continue so long as the funds of the Institution might admit of it. The reasons which induced the COUNCIL to recommend that this practice should be discontinued are obvious, and were explicitly laid before the Annual Meeting last year, when they received the approbation of the Members. Earnest representations had been previously received from many zealous supporters of the Institution suggesting the permanent increase of the subscription to one pound, but, after much consideration, the COUNCIL preferred the optional course which was subsequently adopted.

15. In accordance with the general feeling which had been expressed, the COUNCIL submitted a revised List of Laws relating to the Subscription to a Special General Meeting (a Report of the Proceedings of which appears in page xxii.). The alterations proposed were deliberately adopted, the object being that no Member should be deprived of any privilege he was entitled to, previous to the publication of the Journal; but that all those who wished to receive it should, after the 1st of January, 1860, if they were Annual Subscribers, raise their Annual Subscriptions to £1, and if Life Subscribers should pay an additional sum of £3, or of 10*s.* per annum. The success of this alteration has already been most decided; 834 Annual Subscribers have up to the present time raised their subscription, while 143 Life Subscribers have either paid the increased composition, or 10*s.* subscription.

16. The COUNCIL have further to remark, that it was agreed that Subscribers of £1, while serving abroad, should receive the Journal for a reduced Annual Subscription of 10*s.* if they expressed their wish to that effect. The number in this position is not large; it is a decided advantage to the Institution to retain its Members while on foreign stations, and the supply of the Journal is the only advantage which the Institution can confer upon them during their absence.

The Charter.

17. In consequence of the feeling displayed at the last Annual Meeting in favour of procuring a Royal Charter of Incorporation, the Council made inquiries into the expense which other societies had recently incurred in accomplishing that object. They ascertained the expense of the Charter granted to the Royal Geographical Society, and they considered that it was a fair approximation to the cost which the Institution must encounter for the same purpose.

18. The Council accordingly drew up a Report upon the subject, and submitted it for the consideration of a Special General Meeting (see page xxii.), which unanimously resolved that the necessary steps should be taken to apply for a Royal Charter. A Committee was appointed to prepare a memorial to the Crown, to the prayer of which, Her Majesty has been graciously pleased to accede, and has granted a Charter to the Institution under the title of "The Royal United Service Institution." The various clauses have been framed in strict accordance with the previous existing constitution of the Society.

19. The Council regret that the expense incurred has greatly exceeded their expectations. They had instructed their legal adviser to submit a draft Charter drawn upon the precedents of the Charters of other Societies, for the consideration of the Standing Counsel of the Institution, who insisted upon alterations which were at variance with the constitution of the Society. The Council, conceiving that this difference of opinion was not likely to be removed, although considerable expense had already been incurred, directed that the original draft should be submitted to other Counsel.

20. Objections were subsequently raised by the Law Officers of the Crown to the effect that the property of the Institution could not be vested in the Members; the opinion of the Counsel appointed by the Board of Trade being, that the property must be vested in the Corporation. These differences of opinion have led to an additional outlay, which was beyond the control of the Council; the cost of the Charter amounting to £203 4*s.* 6*d.* The terms of the Charter are, however, almost identically the same as the draft originally submitted to their legal adviser.

Revision of the Laws.

21. The Incorporation of the Members necessitates a revision of the Laws, in order to bring them into harmony with the terms of the Charter. In the Report of last year the Council had recommended that the Laws should be revised for the reasons therein stated; when, however, it was decided to apply for a Charter, the Council postponed the consideration of them, with the exception of the Laws relating to the Subscription, and the first law, describing the design of the Institution; it being necessary, in the latter instance, that such description should partially appear in the preamble of the Charter. The Council submit the Laws to the Meeting in an amended

form, and, in order that the alterations may be clearly understood and comparison facilitated, the several sections of the existing and the revised Laws have been printed in parallel columns. The COUNCIL propose, that, at the close of the Annual Meeting, the Members should resolve themselves into a Special Meeting, for the purpose of taking the said Laws into consideration.

THE TOPOGRAPHICAL DEPARTMENT.

22. This Department, though recently established, is gradually assuming an important position under the superintendence of Colonel Alcock. During the progress of the war in Italy the movements of the hostile forces were, as far as information would permit, defined upon maps, with the strength of the several corps and the names of the commanders. This arrangement not only excited great interest among the Members, but it had the effect of bringing many visitors to the Institution for the purpose of examining the progress of the campaign. The Maps published by the War Department, and the Admiralty Charts, are regularly presented by Her Majesty's Government. The COUNCIL hope still further to extend this Department, and to render it of greater interest to the Members.

THE LIBRARY.

23. The COUNCIL have much pleasure in announcing that they have received from several foreign governments, in exchange for copies of the Journal of the Institution, presents of professional works, which are a valuable addition to the Library, viz.—

FROM THE NETHERLANDS . .	45 Volumes containing the course of instruction at the Royal Military Academy at Breda. 22 Plates of a Topographical and Military Map of the Netherlands.
FROM RUSSIA	3 Numbers of a Military Journal. 20 Numbers of Memoirs of the Military and Naval Topographical Depôt, St. Petersburgh.
FROM DENMARK	1 Volume of a Military, and 1 of a Naval Journal.
FROM SWEDEN	1 Volume of Publications of the Academy of Military Science for 1858, and 1 Number of ditto for 1859.

24. The COUNCIL have also to express their acknowledgments to Her Majesty's Government for the valuable work recently published by the Officers of the Scientific Corps, viz., the Journal of the Operations before Sevastopol.

THE MUSEUM.

25. Although the Museum had been to a great extent re-organised in 1858, a re-arrangement of the rooms will in the course of this year become necessary in consequence of the decision of the Special General Meeting to dispose of the collection of Natural History. The opinions of the COUNCIL

upon this subject were recorded in the Report of last year, and were subsequently confirmed by the Members (see page xxiv.). The model rooms have gradually become crowded with specimens and models of military works and *matériel*, and increased space is required to exhibit them effectually and to extend this collection.

26. The Museum has been enriched during the past year by many objects of practical utility and instruction, viz:—Models illustrating Field Works, and the attack and defence of fortified places; Mining materials, Entrenching Tools, with specimens of raw material used in military manufacture. The collection of Foreign Equipment has been increased by the appointments of a Soldier of the Belgian Line and Rifles, presented by His Majesty the King of the Belgians. The COUNCIL propose to extend still further the collections in the Naval and Military Departments during the present year.

THE LECTURES.

27. The papers which have appeared in the Journal sufficiently prove the ability of their authors, and the Council feel that it is incumbent on them to acknowledge the great advantage which the Institution has derived from the voluntary aid thus afforded. Several lectures were delivered by officers attached to government departments, whose time is much occupied, and to whom the Members are proportionably indebted.

28. The COUNCIL trust, that, in the course of the present year, they may succeed in making arrangements for commencing each Season with a Lecture, containing a complete *résumé* of the progress of Naval and Military Science during the preceding year, and of all recent inventions and improvements which have taken place in Military *matériel*.

HONORARY MEMBERS.

29. The COUNCIL have great pleasure in acquainting the Meeting that the Right Honourable Sir John Lawrence, Bart. G.C.B., to whose cool judgment and distinguished ability, while administering the government of one of the provinces of India, the country is so much indebted, has become an Honorary Member of the Institution.

VICE-PATRON.

30. The COUNCIL regret to record the death of General Sir Thomas Brisbane, Bart., G.C.B., a Vice-Patron of the Institution, and one of the original Members. Sir Thomas served with distinction in the Peninsular War, and was well known for his literary and scientific acquirements.

BEQUEST.

31. By the lamented death of Mrs. Watson, the Institution has lost a warm friend, who had for many years taken a lively interest in its prosperity and had frequently made valuable presents to the Museum. Mrs. Watson

was an Honorary Member, and has proved the estimation in which she held the Institution by bequeathing to it a legacy of £500.

The Trafalgar Model.

32. The Council avail themselves of this opportunity of expressing their thanks to the late Board of Admiralty for having at once acceded to their request by presenting to the Institution a beautifully constructed stand for the Model of the Battle of Trafalgar. The table is a massive oak structure, made of timber removed from "the Victory" when under repair.

33. The Model will not be completed at so early a period as had been anticipated, chiefly owing to its having been found desirable to entrust the execution of it to one person instead of several, as originally intended.

34. This has necessarily entailed delay, but, as the modeller selected is one of the first in his profession, the Council have a guarantee that the work will be done with that accuracy and minuteness of detail appropriate to the representation of so great a battle.

35. The period of the battle selected is that of the Victory passing under the stern of the Bucentaur, at which time the British ships were running down under sail in the appointed order.

The Arctic Relics.

36. After the return of Captain McClintock from his voyage in search of Sir John Franklin and his Comrades, the Board of Admiralty, at the request of Lady Franklin, forwarded for exhibition in the Institution the various relics of that expedition. The Council, recognising the great interest which had existed for so many years as to the fate of Sir John Franklin and his Crew, willingly appropriated a room for that purpose. For eleven weeks the public were admitted to inspect the relics, and no less than 23,600 persons during that time visited the Institution.

Volunteer Corps.

37. The national movement in favour of the formation of Volunteer Corps having received the approbation of Her Majesty and the Government, the Council, anxious to make the Institution available for all Officers connected with the profession of arms, recommend such an alteration in the Laws as will enable the Officers of Volunteer Corps, after appearing in the Gazette, to become Members of the Institution without ballot. The Council propose to insert this alteration in the Revised Laws.

38. In conclusion:—A great movement in advance has now taken place. The Charter of Incorporation alone is calculated to confer dignity upon the Institution and to confirm its stability. The substantial recognition by Her Majesty's Government of the utility and advantage of a professional Insti-

tution is a connecting link between the State and the Members. The great number of Members who have already increased their original subscriptions is a convincing proof of their approbation of the course which has been adopted. The cordial assistance received from Officers of intellectual acquirements, shows that they are anxious to impart information to their comrades, and to advance the interests of their profession by means of the Institution. The COUNCIL trust that the ROYAL UNITED SERVICE INSTITUTION, supported by the sympathy of the Officers of the United Services, may look forward to a successful career, and that, in promoting its own prosperity, it may at the same time advance the service of the country.

IV. Major-General OLDFIELD, R.E. moved—

"That the Report be adopted and printed for circulation among the Members." He must congratulate them upon the increased prosperity of the Institution during the past year; and when they considered the boon that had just been conferred upon them by Her Gracious Majesty, in granting them a Royal Charter, and the honour which they had received from the heir-apparent to the throne by becoming a Member of the Institution, they could not but expect that their prosperity would continue to increase, and that the interest already manifested in the Institution through every branch of both services would be still further extended.

Captain the Hon. A. MURRAY, R.N. said—

After the observations which had been made by General Oldfield, it would be unnecessary for him to do more than to say that he cordially concurred in every word that gallant officer had said, and he begged to second the resolution.

Lieut. GARDINER, R.N. wished to make a suggestion to the Meeting.

They had been summoned to hear the Annual Report read, and then to resolve themselves into a Special Meeting to consider the Bye-laws of the Institution. They had just got into a state of transition, from a sort of club into a corporate body, and, as he took to himself some little credit for having pressed the question of the Charter upon the Institution for several years, he thought he might be permitted to offer one or two observations. He did not wish to move an amendment upon the motion for the adoption of the Report; it was before the Meeting, and let them do as they pleased with it. But what he wished to submit was this: "That the Charter granted by Her Majesty, together with the Bye-laws proposed to be enacted under its provisions, be forthwith sent to every Member of the Institution, and that the consideration of such Bye-laws be adjourned to some future Meeting, to be summoned by the COUNCIL, as soon as convenient, specially for the purpose." He thought it was quite right, when they came to look at what the Institution had done, that every Member in the country should be made acquainted with it; and that, for this purpose, a copy of the Charter and of the proposed Bye-laws should be transmitted to them, and in the meantime the consideration of the Bye-laws should be adjourned to some future Meeting. He hoped the COUNCIL would adopt this as a sort of addenda to the Report, and then adjourn the Special Meeting to some future day, to be named at their convenience. His only object was that the Members should have time to consider the Bye-laws maturely, for, when these laws once had the common seal of the Corporation put to them, they would become very binding upon the Members. He had been advised by persons competent to give advice that there were objections in them, and that the COUNCIL would have to encounter some difficulties if they were not careful. He was told that these Bye-laws had not been submitted to Counsel for approval. In the Charter it was stipulated that the Bye-laws must not be repugnant to the laws of the realm; therefore, they must be cautious to see that this was complied with. As the originator of the movement for getting the Charter, he took the liberty of making this suggestion.

Colonel The Hon. J. LINDSAY, M.P. said—

Perhaps he had better state the course which the COUNCIL had settled to pursue. One part of Lieut. Gardiner's remarks went to this, that a copy of the Charter should be forwarded to every Member of the Institution. That could not be done before they had the Charter. The Charter was only dated the 22nd of February, and the COUNCIL had already settled to send the Charter to every Member. The proposition of the COUNCIL was, that at the close of the Annual General Meeting they should resolve themselves into a Special Meeting for the purpose of entering into the consideration of the Bye-laws. Then, he apprehended, would be the time for Lieut. Gardiner to move any amendment with regard to the Bye-laws that might seem to him desirable.

The CHAIRMAN said—

It did not appear to him, so far as he could judge from the Rules, that this could be called an amendment upon the resolution before the Meeting; nor did he understand Lieut. Gardiner to move it in that shape. It would come more suitably when the Meeting had resolved itself into a Special Meeting to consider the Bye-laws. Then, it would be competent for Lieut. Gardiner to move, as they said in the House of Commons, that the Chairman do leave the chair, or that the Meeting be adjourned. But at the present moment he thought it would be more consonant to the feelings of the Meeting, that he should put the Motion, "That the Report be received and adopted, and printed for circulation among the Members."

The Resolution was put to the Meeting and carried.

V. The names of Eight Members retiring from the COUNCIL by rotation were read:—

W. STIRLING LACON, Esq.	Major-General MATHESON.
Rev. Mr. GLEIG.	Captain NOLLOTH, R.N.
Captain TUPPER.	Lieut.-Col. HOGG.
Commander HOWES, R.N.	Captain GRANT.

VI. Colonel J. C. KENNEDY, C.B. said—

The Resolution which he had the honour to move was one which upon this occasion could not be called one of mere form. It was, "That the thanks of the Meeting be given to the Members of the COUNCIL, who retire by rotation." He was sure he was expressing the feeling of the Meeting when he said they were deeply indebted to the COUNCIL for their labours during the past year. The COUNCIL had not passed through an ordinary year of work. Many of the gentlemen had been employed from morning to night—indeed, he might say, had given up their time for the advantage of the Institution. The year had been marked, not only by the grant of the Royal Charter, but also by the enrolment among them of the Prince of Wales as one of their members. It would also be memorable in the annals of the Institution, he hoped, as a year which would lead to a very large increase of their members, by the admission of those fellow-subjects of theirs, whom, in the name of the Army and the Navy, he might almost call their comrades, in the Volunteers. These were some of the outward labours of the Institution; but there were others, which those who had read the Journal of the Institution knew were of greater importance, viz. the pains which had been bestowed upon the preparation of the papers that had been read in that room, and afterwards published and distributed among the members. There was also another subject upon which he thought they might congratulate themselves; through the care and trouble which the COUNCIL had bestowed upon the performance of their duties, they were in advance of the British Museum, for they had got rid of their beasts and birds, which everybody must be fully aware, if not incompatible with, were certainly an incumbrance to, their Museum. It had now become more professional than it had hitherto been.

The gallant Colonel then moved his Resolution, and in addition proposed,

"That the following Members be the COUNCIL for the year 1860–61 :

Colonel ADAIR.	JOHN BARROW, Esq.	
Captain FOWKE, R.E.	Major-Gen. WATKINS.	
Lieut.-Colonel STUART.	Captain TYLER, R.E.	
Captain COLLINSON, R.N.	Major JERVOISE, R.E.	
Captain PACKE.	W. STIRLING LACON, Esq.	For Re-election.
Captain FISHBOURNE, R.N.	Captain TUPPER.	For Re-election.
Captain JEFFERSON.	Captain NOLLOTH, R.N.	For Re-election.
Sir SIBBALD SCOTT, Bart.	Captain Sir FRED. NICHOLSON, Bart. R.N.	
Lieut.-Colonel READ.	Lieut.-Colonel LANE FOX.	
Rear-Admiral ELLIOT.	Captain MACQUEEN.	
Lieut.-Colonel KEPPEL.	Lieut.-Colonel LE COUTEUR.	
Captain Sir W. WISEMAN, Bart. R.N.	Captain ASTLEY COOPER KEY, R.N."	

The Resolution, having been seconded by Captain GEORGE ST. VINCENT KING, R.N., C.B., was put and carried unanimously.

VII. Vice-Admiral Sir GEORGE TYLER, K.C.B., begged to propose—

"That the thanks of this meeting be given to the Auditors for their valuable services, and that the following gentlemen be elected for the ensuing year :—

JOHN CASE, Esq.	THOMAS SMITH, Esq.
HENRY ELLIOT, Esq.	Captain DOLBY."

He was sure he need not say anything to induce the Meeting to thank these gentlemen, who had used their best endeavours to keep their treasury in order. Looking at the elaborate Report which had been read, he was quite satisfied that they had given a great deal of time and attention to their duties.

Colonel DUNNE, M.P. begged to second the proposition.

He thought the state of the funds was a subject for congratulation. Thirty years ago, when he first joined the Institution, the annual subscriptions were about £600 a year ; now they were more than £2,000 ; and he thought that they were in the way of getting much more. The economy shown by the COUNCIL ought to be a pattern to public institutions. He congratulated the Meeting upon the encouragement which the Government had at last given to the Institution. For many years it had been slumbering. There was no institution that could do so much for the benefit of the services. The moment he heard of it, he joined it, and for many years he had to lament the apathy which prevailed in the services with reference to it. It was for a long period disgraceful to compare the state of education in the service with that of the army of France and of other countries. But he believed that, in this respect, we could now compete with continental nations. He might also congratulate them that the Institution directed attention to practical education. The Government had introduced measures for raising the standard of education in the Army, but he did not think they were so practical as their own. It would be well to show their opinion to Government, that the professional attainments required in our officers should be those which would be serviceable in the profession, and not those which would be useless.

The Resolution was put to the Meeting and carried unanimously.

The CHAIRMAN announced that the business of the Anniversary Meeting was concluded.

(Signed) DE GREY AND RIPON,
Chairman.

B. BURGESS, CAPTAIN,
Secretary.

Lieutenant-General the Hon. Sir E. CUST, K.C.B. moved—

"That Admiral Sir GEORGE BACK do take the Chair."

The Proposition could not require one word from him to make it acceptable to the Meeting. But since he had the opportunity he was desirous of making one observation. He was not aware whether they all knew the extent and value of the Library, but he was anxious to call attention to it, because he thought their thanks were due to the COUNCIL for the extreme liberality with which they placed it at the disposal of those who had occasion to refer to it. It was of extreme value to all who took any interest in military literature, not only from the richness of its contents, but also from the liberal arrangements by which officers were enabled to consult every variety of work upon professional topics. It was of the greater value, because anybody who had experience of the Library at the British Museum knew that it was quite impossible to obtain the same facilities there, which were available in the Library of this Institution.

Major-General STANHOPE seconded the Motion.

Admiral Sir GEORGE BACK accordingly took the Chair.

General Sir WILLIAM GOMM, G.C.B. moved,—

"That the thanks of the Meeting be given to the Earl de Grey and Ripon, for having taken the Chair at the General Meeting, and for the urbanity and kindness with which he had filled it."

Capt. FISHBOURNE, R.N., C.B. had great pleasure in seconding the Resolution.

The CHAIRMAN, in putting the Motion to the Meeting, said,—

He need scarcely observe, that, when the object of the Institution was considered, by no one could the Chair be more appropriately and ably filled than by the noble Under-Secretary of State for War.

The Resolution was put to the Meeting and carried with acclamation.

EARL DE GREY and RIPON—

Sir GEORGE BACK and GENTLEMEN,—I am extremely grateful to you for the kind manner in which you have just passed this vote of thanks. I can assure you that it has been a great gratification to me to be able to be present here to-day. I felt much flattered when my friend Colonel Lindsay first proposed to me that I should take the Chair on this most interesting occasion. For, Gentlemen, although I am afraid I have long been a very unworthy member of this Institution, it does so happen that I am rather an old one. It is now a good many years since, having become an officer in a yeomanry corps in my own county, I joined this Institution. It is, therefore, peculiarly gratifying to me, that, owing to the official situation which I have the honour to fill, you should have thought fit to ask me to preside here to-day. I assure you I entertain the very highest appreciation of the value of the services rendered by this Institution, and which have been rendered by it, especially of late years, to the United Services of the Army and Navy. Gentlemen, we live in times when we see throughout the continent of Europe vast armies in all the greater States. It is, therefore, not surprising that in this country also, our attention should have been directed much more of late years than in past times to all that concerns the defences of the country, and to our naval and military condition. It is not possible, Gentlemen, either from the material circumstances of this country or from our constitutional system, for us to attempt to vie with the great military monarchies of the continent in respect to the numbers of our Army. But, if that be so, it is especially important that the military and naval forces of this country should be raised to the highest possible state of efficiency. I speak more particularly at the present moment of our military forces, because our Navy is of course without a rival in the world. But our military forces are, as I have said, numerically smaller than those of other countries, and unable to vie with them

in that respect. We have been accustomed to count chiefly upon the courage, the zeal, and the devotion of the English soldier; and those will never fail us. But it is also needful now that we should take every means to extend scientific knowledge throughout the Army; and as a scientific profession, for such it ought to be, to raise it to the highest possible state of efficiency. There are peculiar circumstances in these days, if I may be permitted to say so, which render this of especial importance. We live in times when science is becoming of greater value. I trust you will pardon me if I am trespassing at all upon professional ground, upon which, of course, it would be presumptuous for me to enter, except with reference to those general topics that any one who has thought upon the subject may treat of. I say that in these days scientific attainments are peculiarly important in the officers of any army, because of the great changes which are being made in armaments, in regard to both artillery and small arms. Those changes, keeping pace as they do, and as I trust they will, with the great scientific and manufacturing discoveries of later days, are making the Army in every department more and more strictly a scientific profession. Consequently, it is of the greatest importance that every means should be afforded, and that every encouragement should be given, to the officers of the Army to pursue military studies upon a scientific basis. Now, *that* I take to be the object of this Institution; and I take it, that it is becoming increasingly your object from day to day. And now, when you are about to enter, as it were, upon a new phase of your existence,—when you have received, as on this day, a signal proof of Her Majesty's approval of your efforts, it is most fortunate that those efforts should be directed in a channel, which I believe to be the one by which it will be in your power to confer the greatest benefits upon both services. For although it is not unnatural, connected as I am at the present moment with the military profession—not by being a military man myself but by my official position—that I should speak somewhat more of the Army than of the Navy upon this occasion, yet no one has ever doubted that the Navy is pre-eminently a scientific profession; consequently, such means of study as this Institution affords, must be equally useful in the case of the Navy as in that of the Army. You will perhaps permit me, in this assembly of officers of so much distinction, to express to you how high an honour I feel it that I should be connected officially with that great body, the English Army. That is a profession with which any man may well be proud to have even a temporary connection. The English Army has covered itself with glory wherever it has been employed; and I am confident that in these days, when armies are more numerous, when war becomes more scientific, if it ever should be our misfortune to be engaged in war again, the English Army of the future will be found fully equal to that of the past. Gentlemen, I rejoice to find that you are about to open your doors to a new class of Members—I mean the officers of the Volunteer Corps. It is not unnatural that I should allude to that subject, because I have been very much connected with the organisation of that force of late. Now I do not for a moment suppose that the Volunteer Force, whatever may be its number or efficiency, can in any degree take the place of the regular Army. It is not intended in the slightest degree as a substitute for that Army, or for any portion of that Army. But I do believe that, if the time of emergency and external danger should ever arise, the Volunteer Force would be a great assistance to the regular Army, and that, if the members of that force continue to act in the spirit which has hitherto animated them, they would be able, under such circumstances, to render great services to their country. I am sure a better thing could not be done than that, through the medium of this Institution, the officers of the British Army should hold out to the Volunteers the hand of fellowship. The more nearly they can copy your example the better; the more closely you can show them that you sympathise with their efforts, that you are inclined to treat them as your comrades, and not to separate them from you by any feeling of jealousy, or by any notion that they form a body that could for a moment be in rivalry with your own, the more will you add to their efficiency, the more will you be acting in the spirit which has animated Her Majesty in permitting the organisation of that force, and which has induced the illustrious Duke at the head of the Army to connect himself also with the Volunteer Corps. Gentlemen, I must not detain you from other business which calls for your attention; neither, I am sorry to say, can I remain any longer myself on account of official duties which call me away; I will therefore only conclude by thanking you, as I do most heartily and sincerely, for the kind manner in which you have received me on this occasion, and which I assure you has been a source of gratification to me.

PROCEEDINGS

AT A

SPECIAL GENERAL MEETING.

Rear-Admiral Sir G. Back in the Chair.

The Annual Meeting having, on the motion of Colonel Lindsay, seconded by Mr. Stirling Lacon, resolved itself "special," for the purpose of considering the Bye-laws, as framed anew in conformity with the Charter,

The Chairman said—

Before entering upon the business of the Special Meeting, he would briefly remark, that no efforts had been spared by the Chairman, Council, and others, to bring the laws of the Institution in conformity with the Charter, and to advance as much as possible the practical utility of the Royal United Service Institution.

I.—The Notice by which this Special Meeting was convened was read—

Lieutenant Gardiner said—

Feeling as he did that the Institution, years ago, ought to have been incorporated, and having been instrumental last year in inducing the Council to get the Charter, he took some interest in its welfare. It was utterly impossible to alter the Bye-laws without some consideration; and he would propose that, instead of going into the subject now, a copy of the Charter, together with the Bye-laws proposed to be enacted under its provisions, should be sent forthwith to every Member of the Institution, and that the consideration of the Bye-laws be adjourned to a future meeting, to be convened by the Council, as soon as convenient, specially for that purpose. There were many points in them which struck him as being repugnant to the laws of the realm. He recommended that they should first lay them before Counsel, with instructions to draw them in such a way as to steer clear of any rock which they might otherwise split upon.

W. Bryan Cook, Esq., late 85th Foot, seconded the Motion.

Colonel Lindsay said—

He felt bound to oppose the Motion, as perfectly useless and unnecessary. In the first place, the laws were made according to the pre-existing constitution of the Society. The terms of them were slightly altered, either to adapt them to the Charter, or for the purpose of making them plainer. He could not see any object to be gained by an adjournment. When the circulars were sent out, announcing the annual meeting, notice was given that the meeting would resolve itself into a Special Meeting, for the purpose of considering the Bye-laws; therefore, if any gentleman residing at a distance had wished to come up and take part in the meeting, he had full opportunity for doing so. The Council had complied with every regulation in the existing laws. The proposed Bye-laws had been hung up in the Reading-room, so that Members who frequented the Institution could read them and remark upon them, and if they so pleased make

any amendments which were not contrary to the fundamental principles of the Society. Having done so much as this, he thought it would be useless for the Meeting to adjourn; moreover, he might add, that, during the time the Charter was under consideration, these laws were submitted to the legal adviser, though not to the standing counsel. Having explained the course taken by the COUNCIL, he must conclude by asking the Meeting to negative the Motion which the gallant gentleman had put. Duly summoned under the existing laws, under the regulations in force, they were as fully competent to enter into the consideration of the Bye-laws as any Meeting that might be assembled a fortnight or three weeks hence.

Colonel SYKES said—

If the Members present had had the opportunity of comparing the variations between the former and the proposed Bye-laws, and if they were satisfied that they were competent to pronounce an opinion upon the propriety of those variations, then it was entirely in the hands of the Meeting to decide; and there was no necessity for another Meeting to consider that upon which they had already made up their minds. But if the Members had not had an opportunity of forming a judgment, that was a very different matter. It was for the Meeting to judge whether they were in that state of competency or not. If the Bye-laws had been hung up in the Library—(a voice: Fourteen days)—it had been in the power of every Member to come and see what had been proposed by the COUNCIL. If they had not done so, it was their own lâcheté, and not that of the COUNCIL. The Charter had not been sent out to the Members at large, because it had only just been obtained. The Bye-laws could not be sent out to the Members at large, because they had not yet been determined upon. They were brought before the Meeting for the first time. Lieut. Gardiner, therefore, had reason on his side if the Members were not in a position to pronounce an opinion upon the proposed changes: otherwise, he did not see what necessity there was for delaying the decision.

Colonel BURLTON would make a brief remark or two in reply to the gallant officer—

He stated that the Bye-laws had been suspended in the Library. No intimation to that effect had been sent to him; nor was he aware that any Member of the Institution, except the COUNCIL, was aware that they were laid out for inspection there. Until he came into the room that morning he had not the slightest idea of the nature of the proposed alterations. He had had no time to look over them since, and, therefore, he was not competent to pronounce an opinion upon them.

Colonel DUNNE asked—

If it was likely they would get a larger Meeting by delaying the consideration of the question for a fortnight? He did not suppose that a single gentleman now absent would come up to attend an adjourned Meeting. He put the fullest confidence in the COUNCIL that they had done what was best for the Society. They had taken legal advice, and he had that confidence in them that he should vote for the adoption of the Bye-laws as presented to them. And he did not think the delay of a fortnight would give any man a better means of forming an opinion.

Lieut. GARDINER observed—

That the Charter was dated the 22nd of February; consequently the Bye-laws could not have been hung up in the Library fourteen days from that date. He considered this fatal, and that a fresh notice must be given before the Bye-laws could be brought up.*

* A Copy of the Charter as granted, before being actually sealed, from which the laws were framed, was in possession of the COUNCIL upwards of fourteen days previous to the Special Meeting.—ED.

The CHAIRMAN said—

The COUNCIL had informed the Members of the Institution in the best way they could. With respect to Lieut. Gardiner's objection about the insufficiency of the notice, it was true you could not make fourteen days out of a less number. But according to the old laws, Section XII., "should it be proposed to make or repeal a fundamental law, the proposition to such effect, signed by the proposer and seconder, shall be suspended for fourteen days in the Library." The Secretary was not to announce to everybody that there was a new law suspended there, it was only provided that it was to be hung in the Library. This had been done. Colonel Lindsay and Colonel Sykes had explained what the COUNCIL had done; therefore he had nothing more to do than to put the motion for an adjournment.

The motion was then put, and negatived by a large majority.

Lieut. GARDINER said—

That the names of the proposer and seconder were not attached to the proposed Bye-laws.

Colonel LINDSAY replied—

That the signatures of five Members of COUNCIL were attached to the proposed alterations in the Bye-laws which were suspended in the Library.

II.—The SECRETARY produced and exhibited the original document, as suspended in the Library; and, at the request of the Chairman, then read the several sections of the amended Bye-laws.

The CHAIRMAN asked—

If it was the pleasure of the Meeting that these should be received as the Laws of the Institution.

Lieutenant GARDINER said—

He had one or two objections to make. In the second section, "Composition," he would leave out the words "by ballot" in the second paragraph. He thought it was rather an invidious thing that these gentlemen should be balloted for in the Institution, especially when the class mentioned in the first paragraph were not elected by ballot. Then in the third section, "Government," he thought this part might be left out: "The COUNCIL shall submit to the Annual General Meeting a list of names from which the vacancies may be filled." He thought it should be left to the opinion of the General Meeting, without the COUNCIL recommending who should fill the vacancies. It was a course not generally adopted in other institutions. Then he came to the fourth section, "Subscription." There, he ventured to say, that unless they were very careful they would get into some difficulty. It was a question, so he was informed, whether they had the power to make a prospective law to compel Members who had subscribed for years, and whose funds had been appropriated to the enlargement of the Institution, to give an increased subscription, in order to be furnished with the Proceedings of the Institution. It was not fair to these gentlemen, who had been in the habit of paying 10*s.* a-year, and whose funds had upheld the Institution when it was in a state of insolvency nearly, that they should be called upon to pay an increased £3, and an additional subscription of 10*s.*, or else be curtailed of privileges that would be given to those who came in later (cries of "No, no.") He thought the section altogether, especially that part of it, objectionable. They ought not to make it compulsory, or say "You shall not have that which the Corporation produces." Therefore, on all these grounds, he thought it would be better to bring that clause back to its original condition. Then he thought the latter part of clause 4 objectionable, and that it should be left out; for if an officer was going abroad he ought not to be called upon to notify it to the Secretary; inasmuch as it would be known officially that he was going abroad.

Captain FISHBOURNE said—

There was a certain point in Lieutenant Gardiner's objection. The only way was to look at it from a practical point of view. The COUNCIL had hitherto given to every Member a copy of the Journal; but they found from the expense that they could do this no longer. Now, Mr. Gardiner wanted the COUNCIL to do that which they could not do, because they had not the funds to do it. He complained that the COUNCIL were appropriating the money of the Members. Now, this was what they wanted to avoid. They found they could not give copies of the Journal to every Member. Therefore, the only thing they could do was to give it to those who would pay for it. Mr. Gardiner complained of money being taken out of other people's pockets, and yet he asked to be furnished with the Journal at the expense of other people. Granting that this proposition was carried, then, as a necessary consequence, as they had no funds to print the Journal and furnish every Member with a copy, they must come to the resolution to have no Journal at all. They knew very well that the effect of the Journal had been immense; it had given an impulse to the Institution which it seemed Lieutenant Gardiner wished to stop; he wanted the Institution to fall back to the original position from which it had been raised.

Lieutenant GARDINER said—

He was not to be carried away by these plausible observations. He did not mean anything of the kind that Captain Fishbourne attributed to him. If the Journal was so valuable, let it be sold to the Members, and then they would get rid of the difficulty.

Colonel LINDSAY said—

There was one point that ought to be brought under the notice of the Meeting. When the COUNCIL brought out the Journal, they stated in the Annual Report at the time, and also in the next Annual Report, that they intended to give the Journal to all the Members of the Institution, *only so long as the funds would enable them to do so.* (Hear, hear.) The whole question, from first to last, turned on *that.* The COUNCIL never provided that they would continue to print and issue the Journal free of expense, and send it abroad to all stations free of charge, unless they found they could afford to do so. They found, as stated in the Report this year, that no less than 3,000 Members wanted the Journal. In the first instance, the COUNCIL calculated that not more than 2,000 at the very utmost would be required; in fact, not 1,500, for he was sorry to say that at that time there were not 1,500, or even 1,000 Members who took an interest in the Institution. They calculated upon 1,500 being required, and they printed 2,000 in order to have 500 copies in hand. Gradually, the Members found the Journal so valuable, that they very soon came to the Institution and asked for it, and the COUNCIL had to print an additional 1,500 copies in order to meet the demand. They had adhered religiously to their engagement up to this time; they had sent the Journal to all parts of the world, but last year they were only enabled to do so at the expense of other departments of the Institution. They therefore appealed to the Members upon the basis they started with two years and a half ago, when the Journal first appeared, and Members had responded to the call. They submitted the case last year to the Members, and the Members approved of the course they proposed to pursue—that in order to be entitled to the Journal they should pay an increased subscription. Those Members who did not wish to pay the increased subscription would have all that they had before the COUNCIL commenced the publication of the Journal. He was happy to add that there was not much danger of there not being a sufficient number of Members to pay for the whole expense of the Journal, including the Members who might be serving abroad, and who would only pay the reduced subscription. For it was announced in the Report that 834 annual subscribers had, up to the time the Report was printed, raised their subscriptions, and since then there had been an addition of something like forty more; and three days ago an additional forty had been added to the subscription list of officers connected with the Guards. The result was, there were about 920 subscribers of £1 each, in addition to 143 life sub-

scribers, who had increased their composition by £3. They had, consequently, about 1,100 Members who had increased their subscriptions, and he did not hesitate to say that the number would be increased to 1,200. They should therefore have ample funds to pay the full expenses of the Journal without causing 6*d.* expense to those who did not wish to join in taking it.

Captain SWENY, R.N.—

Expressed his regret that Lieutenant Gardiner was a person with whom he unfortunately invariably differed in opinion. He submitted to the Meeting whether anything could be more liberal, than that, for the trifling subscription of ten shillings, the Journal, which it was generally admitted was a most valuable production, should be sent to Members at a distance; therefore no one could complain that officers on duty abroad did not receive some benefit for their subscription. He thought they were deeply indebted to the COUNCIL for their exertions in improving this valuable and important Institution. So far from it being in the desponding state he remembered it five years ago, they had restored the confidence of the public and of British officers to such an extent, that they were now coming in, in large numbers, upon the increased subscription.

Captain SWENY concluded his speech by an elaborate statement of the expenses connected with the Journal.

Lieut. GARDINER said,—

He would propose that all Life Subscriptions should be invested in the public funds in the name of the corporation.

Colonel LINDSAY observed,—

That it was already in the Charter, that all Life Subscriptions should be vested in eligible securities.

Lieut. GARDINER said,—

He would come to that section presently. He had no further observation to make upon the fourth.

Major BOILEAU said,—

Every one present must be desirous to make the Bye-laws as valuable as possible, and that was the only excuse he had to offer for trespassing upon their attention. The suggestion he had to make was with reference to Section III, "Government." It was there stated, that the COUNCIL should submit to the Annual General Meeting a list of names from which the vacancies may be filled. Now, observe the practical operation of that. Out of the eight members who went out by rotation, five would not be eligible for re-election; consequently, there must be five different persons to fill the places of those five. Now, "the COUNCIL," it said, "shall submit to the Annual Meeting a list of names from which the vacancies may be filled." It would appear that the filling up of those vacancies was to be limited to the list of names submitted by the COUNCIL. The present COUNCIL would believe that he did not wish to throw any imputation upon their perfect fairness, but these rules would be in force long after the present COUNCIL was taken from this world: therefore, it was desirable to consider what would be the practical working of that rule hereafter. It might be that at some future time the COUNCIL would only submit five names, and the consequence would be that the General Meeting would have no option but to take the names thus recommended by the COUNCIL. Now, he did not think *that* a proper position for the Institution to be placed in. He therefore submitted to the consideration of the COUNCIL, whether it would not be desirable, instead of saying the COUNCIL shall submit a list of names, to state that there should be a certain number of names submitted, say ten, so that the clause should read, "The COUNCIL shall submit to the Annual General

Meeting a list of not less than ten names from which the vacancies may be filled." Such a provision would allow of a little choice to the Meeting, instead of limiting them to five names only. If ten was not the right number, he would suggest any other number.

The Amendment, after being seconded by Captain WHEATLEY, R.N., and after some remarks from Mr. LACON, Colonel LINDSAY, and Captain FISHBOURNE, was put from the Chair and carried.

The CHAIRMAN asked,—

If any other gentleman wished to offer any remark upon the Bye-laws.

Lieut. GARDINER said,—

He wished to make a remark about the "Funds," Section V. It said "that the Funds of the Institution and all Life Subscriptions and Legacies shall be invested in eligible securities in the names of Trustees selected by the COUNCIL." He would propose to leave out "eligible securities," and substitute "government securities." And in the room of "in the names of Trustees," substitute "in the name of the CORPORATION." He had seen cases, where, in the event of a Trustee dying, parties were put to a considerable expense in supplying another trustee. If the funds were invested in the name of the corporation, no difficulty of the kind could occur, because the corporation never died.

Mr. LACON explained,—

That the section in question had been drawn up in conformity with the Charter, into which the clause relating to Trustees had been inserted at the express direction of the law officers of the Crown.

The Amendment, not being seconded, fell to the ground.

The remaining sections having been gone through without objection,

Mr. LACON, seconded by Major BOILEAU, proposed,—

In Section III. paragraph 9, that the words "and the said appointments shall be considered as being held only from year to year," be struck out.

Which was agreed to.

The CHAIRMAN then put the question,—

"That the Bye-Laws, as amended, be the Bye-Laws of this Institution."

Carried *nem. con.*

The CHAIRMAN announced that the business of the Meeting was concluded.

(Signed) G. BACK, REAR-ADMIRAL,
Chairman.

B. BURGESS, CAPTAIN,
Secretary.

III.—It was proposed by Captain PACKE, seconded by Lieut.-Colonel ALCOCK, and carried unanimously, that

"The thanks of this Meeting be given to Admiral Sir G. BACK for his kindness in taking the Chair on this occasion."

APPENDIX.

PROCEEDINGS AT A SPECIAL GENERAL MEETING.

At a Special General Meeting of the Members of the UNITED SERVICE INSTITUTION, held in the Theatre of the Institution, at Two o'clock, P.M., on Saturday, the 16th April, 1859,

His Grace the DUKE of NORFOLK, Vice-Patron, in the Chair.

I. The Notice by which this Special General Meeting was convened was read.

II. The Report of the COUNCIL on the subject of applying for a Charter was read, as follows :—

The COUNCIL have had under their consideration the propriety of presenting a humble Petition to Her Majesty, praying her to grant to the Members of the United Service Institution "A Royal Charter of Incorporation."

Being deeply impressed with the rising and important position which the Institution is assuming, and believing that the incorporation of the Society will give it permanence and stability, and add materially to its efficiency, the Council decide to call a Special General Meeting of the Members for the purpose of taking into consideration this subject, and such other matters as may be brought before it, due notice to be given according to the provisions of Section XI. of the Laws.

The COUNCIL desire to submit the following reasons for the consideration of the Members.

1st. That the possession of a Royal Charter would place the Institution in a higher position among scientific societies, and would tend to raise its character in public estimation, and ensure its permanence.

2nd. That the legal enrolment of the Institution as a corporation would enable it to raise or defend an action in its own name, and do away with the individual responsibility of its Members.

3rd. That the costs which are now repeatedly incurred by the Institution in the alteration of the trust deed, owing to changes in the names of the Trustees, &c. would be avoided.

4th. That under the provisions of a Charter the Institution would be able to receive and hold property of any description in its own name, whereas at present, legacies made to the Institution might be rendered void by reason of inaccuracies in the form of the bequest, or by the omission to place such property in trust, mistakes in the names of the trustees, &c.

PROBABLE COST.

The COUNCIL have ascertained that the cost of obtaining a Charter by the Royal Geographical Society was £151; and that incurred by the Royal Naval Benevolent Society was—

	£	s.	d.
For fees	100	0	0
Lawyer's charges . . .	27	2	2
	£127	2	2

The COUNCIL are of opinion that these two instances will suffice to give a fair approximation to the cost which would be incurred by the Institution.

Signed, JAMES LINDSAY, Colonel,
Chairman of the Council.

UNITED SERVICE INSTITUTION,
28th March, 1859.

III. It was moved by Colonel LINDSAY, and seconded by Colonel YORKE—

That this Meeting do adopt the recommendation of the COUNCIL, and empower them to take the necessary steps to obtain a Charter of Incorporation.

Carried *nem. con.*

REVISION OF THE LAWS.

IV. The Report of the COUNCIL upon the Revision of the Laws was read.

1st. In the Annual Report of this year the Council drew the attention of the Members to the necessity which, in their opinion, existed for a revision of the Laws; and in paragraph 33 they recommended that the question should be brought under the consideration of a Special General Meeting during the present season.

2nd. The principal alterations which the Council recommended are contained in the First and Sixth Sections.

In the first Law the description of the design is feeble, and does not adequately represent the character and object of the Institution. The COUNCIL propose to remedy this defect by making the intellectual and scientific development of the design more prominent, and by giving a fuller description of the means by which they seek to promote Naval and Military Art, Science, and Literature. They also propose to omit the words "Natural History," respecting the collection of which the opinions of the COUNCIL have been given (in page 8 of the Annual Report).

With regard to the revision of those Laws which regulate the Subscriptions (Section VI.), the COUNCIL have stated at length, in the Annual Report (pages 6 and 7), their reasons for the alterations they recommend.

As many of the other Sections of the Laws require amendment, in consequence of some of the provisions having become obsolete, and it being necessary to adapt others to the present circumstances of the Institution, the COUNCIL submit the Laws to the Meeting in an amended form, and, in order that the alterations may be more clearly understood, and comparison facilitated, the several Sections both of the Existing and the Revised Laws have been printed in a relative position to each other.

(Signed) JAMES LINDSAY, Colonel,
Chairman of the Council.

Colonel Lindsay announced that, it being decided to apply for a Charter, the COUNCIL only proposed to press the revision of the first Section, relating to the design, and of the Sixth Section, affecting the subscriptions, and to postpone the consideration of the remaining Laws until after the decision of the Crown upon the application be known.

V. The present design of the Institution, as contained in Section I. of the Laws, and the proposed alterations were then read.

PRESENT LAWS.	REVISED LAWS.
SECTION I.—DESIGN.	SECTION I.—DESIGN.
1. The United Service Institution is founded as a Central Repository for objects of Professional Art, Science, and Natural History, and for Books and Documents relating to those Studies, or of general information. The delivery of Lectures on appropriate subjects is included in the design of the Institution.	1. The promotion of Naval and Military Art, Science, and Literature, is the object of the United Service Institution (originally called the Naval and Military Museum). 2. The principal means by which this object is sought to be attained are,—the formation of a Library containing Historical, Scientific, and Professional Works, Maps, Charts, and Plans; the delivery of Lectures; the exhibition of Inventions; and the publication of a Journal; a collection of Arms of all Nations; and a Museum, which shall serve as a Central Repository for objects of Professional Information, and for Trophies and Relics, &c., connected with distinguished Officers, and Naval and Military operations.

VI. It was moved by Captain FISHBOURNE, R.N., and seconded by Captain GRANT—

That this Meeting do adopt Section I. of the revised Laws as now read.

It was proposed by Lieut. GARDINER, R.N., and seconded by Major RHODES—

That this meeting do adjourn till after the Charter be obtained.

This amendment was put from the Chair, and lost, and the original Resolution carried.

VII. It was moved by Lieut.-Colonel ALCOCK, and seconded by Lieut.-Colonel READ—

That this Meeting, having sanctioned the revision of Section I. of the Laws, do authorise the COUNCIL to dispose of the Zoological and Botanical Specimens in the Museum in such manner as will most benefit the interest of the Institution.

After some remarks from Sir RAYMOND JARVIS, the Resolution was put from the Chair and carried.

VIII. Section VI. of the Existing Laws, and Section IV. of the Revised Laws, were then read.

PRESENT LAWS.	REVISED LAWS.
SECTION VI.—SUBSCRIPTIONS.	SECTION IV.—SUBSCRIPTIONS.
1. An Entrance Fee of One Pound shall be paid by all Members on joining the Institution.	1. An Entrance Fee of One Pound shall be paid by all Members on joining the Institution.
2. The Annual Subscription shall be not less than Ten Shillings, due on the 1st of January.	2. Annual Subscriptions shall be due on the 1st of January in each year; Subscribers of not less than One Pound a year, shall, after the 1st of January, 1860, be entitled to receive the Numbers of the Journal commencing in the year in which they become Members.
3. The payment of the sum of not less than Six Pounds, in addition to the Entrance Fee, shall constitute a Member for Life.	3. Annual Subscribers of Ten Shillings, shall, after the 1st of January, 1860, receive, as heretofore, the Annual Report, but not the Numbers of the Journal.
4. Any Member failing to pay his Annual Subscription for two successive years shall cease to be a Member, unless the Council should see reason to decide otherwise.	4. After the 1st of January, 1860, all Subscribers of One Pound a year shall, while serving on Foreign Stations, have their Subscriptions reduced to Ten Shillings a year, commencing on the 1st of January succeeding their embarkation, if they express their wish to that effect in writing to the Secretary.
5. Members withdrawing from the Institution re-admissible only on payment of arrears, unless the Council should see see reason to decide otherwise.	5. Life Subscriptions. After the 1st of January, 1860, the payment of a sum of Nine Pounds in addition to the Entrance Fee shall constitute a Member for Life, who shall be entitled to receive the Numbers of the Journal commencing in the year in which he becomes a Member.
	6. Life Subscribers of Six Pounds in addition to the Entrance Fee shall receive as heretofore the Annual Report, but not the Numbers of the Journal.

7. Annual Subscribers of Ten Shillings, and Life Subscribers of Six Pounds, while serving abroad, shall be entitled during such service to receive the Current Numbers of the Journal, on notifying their wish to that effect to the Secretary in writing.

8. Members who join the Institution on or after the 1st of October in any year shall not be charged the next Annual Subscription on the 1st of January.

9. Members failing to pay their Annual Subscription shall be liable to have their Names removed from the List of Members at the discretion of the Council.

10. Members withdrawing from the Institution, or whose names have been struck off for non-payment of their Subscriptions after repeated applications, shall be re-admissible only on payment of arrears from the date of last payment.

IX. It was moved by Captain PACKE, and seconded by Major WHITE—

That this Meeting do adopt Section IV. of the Revised Laws as now read.

It was moved by Lieutenant GARDINER, R.N. and seconded by Captain YONGE, Royal Artillery—

That this question be adjourned till after the obtaining of the Charter.

After some remarks from Sir SIBBALD SCOTT, Captain PACKE, Colonel LINDSAY, Captain FISHBOURNE, R.N., and Major RHODES, the Amendment was put from the Chair and lost.

It was moved by Major RHODES, and seconded by Lieutenant GARDINER, R.N.—

That the Subscription List should be so altered that Subalterns should pay Five Shillings, Captains Ten Shillings, Field Officers One Pound, and General Officers One Pound Ten Shillings, each to receive a Copy of the Journal whether at home or abroad, and that the corresponding Ranks in the Navy should pay in the same way.

After some Remarks from Captain FISHBOURNE, R.N., and Lieutenant GARDINER, R.N., the Amendment was put from the Chair and lost.

The original Resolution was then put from the Chair, and, after a few remarks from Sir RAYMOND JARVIS, Colonel LINDSAY, Captain GODBOLD, and Colonel SYKES, was carried.

The Chairman then announced that the business of the day was concluded.

(Signed) NORFOLK, E.M. Chairman.

B. BURGESS, Captain, Secretary.

STATEMENT OF CHANGES AMONG THE MEMBERS SINCE 1ST JANUARY, 1859:—

	Annual.		Life.		Total.
Number of Members on 1st January, 1859 .	2423	+	823	=	3246
Do. who have joined during 1859 .	176		19		195
	2599		842		3441
Changed from Annual to Life . . .	— 10		+ 10		
	2589		852		3441
Deduct—Deaths during 1859 . . 68 21					
Withdrawals . . . 13					
	76		21		97
Number of Members on 1st January, 1860 .	2513		831		3344

TABULAR ANALYSIS OF THE STATE OF THE INSTITUTION,

To the 31st of December, 1859.

Year. 1st Jan. to 31st Dec.	Annual Subs. received.	Entrance Fees.	Income (from all sources).*	Life Subs. received.	Amount of Stock.	Invested in the purchase of Books, &c.	No. of Vols. in Library.	No. of Members on the 31st Dec.	Number of Visitors.
	£	£	£	£	£	£			
1831	654	..	654	1,194	..	..	..	1,437	..
1832	1,146	..	1,146	973	..	..	..	2,699	..
1833	1,405	..	1,450	692	..	..	..	3,341	..
1834	1,500	..	1,549	583	1,100	..	..	3,748	13,376
1835	1,480	..	1,574	366	2,430	40	..	4,155	8,537
1836	1,570	..	1,682	330	3,747	45	..	4,069	8,521
1837	1,549	..	1,747	222	4,747	180	..	4,164	10,907
1838	1,462	..	1,634	230	5,500	246	..	4,175	15,788
1839	1,399	..	1,565	168	5,500	292	..	4,186	16,248
1840	1,363	..	1,525	198	5,500	446	5,500	4,257	17,120
1841	1,450	..	1,643	186	6,000	243	5,850	4,243	19,421
1842	1,373	..	1,565	144	6,400	373	6,450	4,127	21,552
1843	1,299	..	1,494	140	6,700	237	7,000	4,078	27,056
1844	1,274	..	1,408	112	3,000	298	7,850	3,968	22,767
1845	1,313	..	1,466	228	1,500	127	8,100	3,988	21,627
1846	1,298	..	1,456	138	1,500	74	8,410	4,031	32,885
1847	1,314	74	1,502	132	1,700	37	..	4,017	38,699
1848	1,175	57	1,375	48	1,700	85	9,641	3,947	37,140
1849	1,176	72	1,375	84	1,150	58	..	3,970	33,333
1850	1,141	106	1,294	198	600	36	..	3,998	33,773
1851	1,136	131	1,292	66	666	34	10,150	3,188	52,173
1852	1,134	133	1,281	114	200	43	10,300	3,078	20,609
1853	1,243	319	1,684	264	528	41	10,420	3,251	25,952
1854	1,200	138	1,368	126	612	95	10,587	3,171	22,661
1855	1,159	107	1,289	120	653	55	10,780	3,131	14,778
1856	1,216	197	1,519	156	761	47	10,832	3,204	16,184
1857	1,258	176	1,937	78	1,038	40	10,960	3,168	12,755
1858	1,318	221	2,102	105	438	31	11,062	3,246	25,747
1859	1,526	195	2,277	512	946	70	11,320	3,344	28,739

* Including Annual Subscriptions, Entrance Fees, Donations, Legacies, and Interest on Funded Property; and also the grant from Government, commencing in 1857.

LIST OF DONATIONS

FROM 1ST JANUARY TO 31ST DECEMBER, 1859.

	£	s.	d.
WALES, H.R.H. Prince of	20	0	0
Aitchison, *Sir* John, Gen. KCB.	2	0	0
Anderson, George, Surg.-Major	1	0	0
Atkinson, Francis B., *Esq.*	2	0	0
Barrell, Justinian, Capt. R.N.	0	10	0
Blair, W. F. Capt. R.N.	1	0	0
Blakeley, A. T. Capt. h.p. R.A.	0	10	0
Boileau, C. L. Major late R.B.	1	0	0
Carter, W. G., F.S.A., *Esq.* Sol. S. F. Gds.	1	1	0
Clinton, H. R. Ens. and Lieut. G. Gds	3	0	0
Cookes, Geo. Capt. late 3rd Lt. Drs.	5	0	0
Crawfurd, John, *Esq.*	5	0	0
Crozier, R. Rear-Adm.	0	10	0
Edward, Henry Rear-Adm.	1	0	0
Holden, Henry Lt.-Col. 13th Lt. Drs.	1	1	0
Jefferson, R. Capt. late Ceylon Rif.	1	0	0
King, R. H. Rear-Adm.	2	0	0
Lawrence, *Right Hon. Sir* John, Bart., GCB.	5	0	0
Lewis, Geo. G. Lieut. R.E.	1	0	0
Macdonald, Alex. Col. unatt.	1	1	0
Macleod, D. Major-Gen.	1	0	0
MacQueen, Jas. Capt. h.p. 3rd. Lt. Drs.	0	10	0
Carried forward	£56	3	0

	£	s.	d
Brought forward	56	3	0
Monro, D. A. Maj. late 12th Lns.	1	0	0
Moore, W. W. Col. late Ben. A.	1	0	0
Murray, P. K. Capt. G. Gds.	2	0	0
Narrien, John, *Esq.*	0	10	0
O'Grady, Hayes Vice-Adm.	2	0	0
Packe, Edmund Capt. late R.H. Gds.	1	0	0
Pakington, *Sir* John, KCB. First Lord of the Admiralty	5	0	0
Pollock, *Sir* Geo. Gen. GCB.	2	0	0
Rea, Edward Col. R.M.	1	0	0
Rhodes, Godfrey, Major unatt.	3	0	0
Rich, G. W. T. Lt.-Col. 71st Highland L. I.	2	0	0
Ripon, Earl of	2	0	0
Skey, Jno., M.D. Insp. Gen. of Hospitals	1	0	0
Sefton, Earl of	5	0	0
Stilwell, J. G. *Esq.* Navy Agent	2	0	0
Tyler, H. W. Capt. R.E.	4	5	0
Tyler, *Sir* James late Hon. Corps Gent.-at-Arms	12	15	0
Vyvyan, R. H. S. Lieut. Cornwall Rang.	1	1	0
Waddilove, C. L. Com. R.N.	2	0	0
Western, J. R. Col. Beng. Engs.	2	0	0
Wright, Charles Col. R.E.	5	0	0
Total . .	£113	14	0

LIST OF NEW MEMBERS

WHO JOINED THE INSTITUTION SINCE THE LAST EVENING MEETING IN 1859 (30TH MAY).

LIFE MEMBERS.

WALES, H.R.H. the Prince of.
Fitzgerald, H. C., Major 33rd Regt.
Breton, P. Wright, Capt. Hants. Mil.
Chambers, Montague, Lieut. h.p. 71st. Regt.
Godman, R. Temple, Capt. 5th Drag. Gds.
Cracroft, Peter, Capt. R.N.

ANNUAL SUBSCRIBERS.

Salwey, Alfred A., Com. Gen.
Oakley, Geo., Capt. 84th Regt.
Northey, E. R., Capt. late 52nd Regt.
Calderon, C. M., Cornet 4th Lt. Dgs.
Johnstone, Hon. H. Butler, M.P., Maj. Dumfries Mil.
Bulwer, E. G., CB., Lt.-Col. 23rd R. W. Fus.
Burrard, *Sir* Geo. *Bart.*, Dep. Lieut. Hants.
Robinson, *Sir* G. A. Maj. 22nd Regt.
Stacey, Wm. Jno. *Esq.*, War Office.
Strickland Edward A., Com. Gen.
Grimston, M. J., Capt. East York Mil.
Cairnes, Wm. Capt. 21st R. N. B. Fus.
Nelson, Thomas, Surgeon R.N.
Marillier, C. H., Ens. Cape M. Rifles.
Chichester, C. R., Maj. 97th Regt.
Fitzgerald, M., Lieut. 97th Regt.
Manners, A. C., Ens. 57th Regt.
Peyton, Francis, Lt.-Col. 98th Regt.
Wilkie, Jno. L., Capt. 12th Regt.
O'Brien, Wm. C., Capt. 73rd Regt.
Rochfort, Jno. de Burgh, Lieut. R.A.
Alston, A. H., Lieut. R.N.
Nuthall, W. F., Major 18th Beng. N. I.
Baring, D. H., Ens. & Lieut. C. Gds.
Lloyd, Fras. Thos., Lieut. R.A.
Graham, Fras. B., Forfar and Kincardine Mil. Art.
Wilson, R. S., Capt. 52nd Mad. N. I.
Noble, Jno. Geo., Capt. 1st Roy. Lan. Mil.
Webber, Geo., Lieut. R.N.
Bowles, R. F., Capt. late Roy. Berks Mil.
Seymour, L. R., Lieut Gren. Gds.
Forbes, Francis, Lt.-Col. ret. Mad. Cavalry.
Phibbs, Richd., Major 4th Roy. Lan. Mil.
Brown, Thos., Chief Engineer R.N.
Owen, C. Cunliffe, Capt. R.N.
Gibson, Chas. E., Capt. 49th Regt.
Clerk, John, Capt. Rifle Brigade.
Berger, Ernest A., Lieut. 10th Regt.
Ellesmere, *Earl* of, Lt.-Col. Lan. Yeo. Cav.
De Gruchy, W. L., Ens. 4th R. Jersey Mil.
Edgar, Josh. Haythorne, Lieut. R.A.
Bazalgette, S. A., Lieut. R.A.
Stopford, G. M., Major R.E.
Gordon, C. H., Capt., R.E.
Perceval, Jno. J., Lieut. 17th Regt.
Steward, Edwin A. T., Major 21st R. N. B. Fus.
Baker, T. D., Capt. 18th Royal Irish.
Bird, Edward, Capt. R.N.
Cook, Henry, Capt. 100th Regt.
Chapple, Edward, Lieut. 95th Regt.
Hartley, W. G., Capt. Roy. Denbigh Rifles.
McBean, Wm., Capt. 22d Regt.
Fyler, Jno. W. T., Lieut. 31st Regt.
Goodwin-Austen, H. H., Capt. 24th Regt.
Marsh, Augustus, Major late 55th Regt.
Prendergast, H. N. D., Lieut. Mad. Engrs.
Farrier, Jas., Quar.-Master Roy. Hosp. Chelsea.
Fairholme, Charles, Lieut. R.N.

Gibbs, Charles, Capt. 2nd Queen's.
Inglefield, J. H., Lieut. 38th Beng. N. I.
Brooke, Edw. T., Lieut. Royal Engrs.
Guildford, *Lord*, Capt. R.N.
Carey, Geo. Jackson, Col. Cape M. Rifles.
Nelson, Horatio, Com. R.N.
Steele, Aug. F., Lt.-Col. 9th Roy. Lancers.
Waite, F. J. S., Lieut. Fife Artillery.
Anderson, Wm., *CB.*, Col. (ret.) Beng. Art.
Baxter, Stafford Squire, Capt. 1st War. Mil.
Moorhead, C., Surgeon Bom. Establishment.
Field, E., Com. R.N.
Marvin, Wm., Major, Chief Paymaster Roy. Artillery.
Smyth, Henry, *CB.*, Col. 76th Regt.
Meaden, J., Capt. Ceylon Rifles.
Heathcote, J. A., Lieut. Indian Navy.
Chamberlain, *Sir* Henry O. R., Capt. Hon. Corps Gent.-at-Arms.
Tullibardine, Marquis of, Lieut. Sco. Fus. Gds.
Grover, G. E., Lieut. Royal Engineers.

ADDITIONS TO THE LIBRARY AND MUSEUM

SINCE THE 30TH MAY, 1859.

LIBRARY.—BOOKS.

(*The Donors' Names in Italics.*)

ACADEMY OF MILITARY SCIENCE, STOCKHOLM, 1 Vol. of the Publications of, for the year 1858. 1 No. of ditto for 1859. *The Swedish Government.*

ACHARD, AMEDEE. *Montebello — Magenta — Marignan.* Lettres d'Italie (Mai et Juin, 1859). Paris. 8vo. 1859. *John Barrow, Esq. F.R.S, &c.*

ARMSTRONG (Robert), on High Speed Steam Navigation and Steamship Perfection. Pamph. 8vo. London, 1859. *The Author.*

ART UNION OF LONDON. Twenty-third Annual Report of the Council, with list of Members. Six Almanacs—1860. *The Society.*

ASPLAND (Alfred) Esq. F.R.G.S. An Examination of the Report of the Commissioners to inquire into the Mortality of the Army. Pamph. 8vo. 1859. *The Author.*

BARNARD (J. G.) Major, U.S.A.

The Gyroscope. Pamph. 8vo. New York, 1858.

The Dangers and Defences of New York. 1859. *Captain Burgess.*

BARROW (John) Esq. F.R.S. Nos. 5, 6, 7, of Everybody's Journal, containing Papers on the Battle-fields of Italy in 1859. *The Author.*

BLUE BOOKS:

Report from His Majesty's Commissioners for inquiring into the system of Military Punishments in the Army. London, 1836.

Report relative to Military Affairs in Asiatic Turkey and the Defence and Capitulation of Kars. London, 1856. *Lt.-Col. J. G. Robinson.*

BRITISH ASSOCIATION for the Advancement of Science, Report of the Twenty-eighth Meeting of. Leeds, 1858. London. 8vo. 1859. *The Association.*

CATALOGUE OF MAPS, in the Library of the Topographical Department. Vols. I. and II. 1859.

Ditto, ditto, Additions to the Collection of Maps and Plans at the Topographical Depôt War Office to 31st October, 1852. 2 Sheets, 4to. *Secretary of State for War.*

CHARLESWORTH (E.) Esq. F.G.S. Remarks on Gun Accidents and on the Safety Elevator in the Construction of Fowling Pieces and Rifles. Pamph. 8vo. London, 1859. *The Author.*

COLES (Cooper P.) Capt. R.N. A cheap and simple mode of protecting our Mercantile Ports and Navigable Rivers. Pamph. 8vo. London, 1859. *The Author.*

CORNARO (Lewis). Sure Method of attaining a Long and Healthful Life, with the means of correcting a Bad Constitution. Translated from the Italian. 45th Edition. 12mo. London, 1823. *Captain Carr.*

CHARLES (L'Archiduc) A.S.A. Principes de la Stratégie. 2 Vols. in 1, Paris, 1818, with 1 Vol. of plates.

CAMPAIGN DE 1799, en Allemagne et en Suisse, 1 Vol. Vienna. Paris, 1820, with 1 Vol. of plates. *Lt.-Gen. Sir George Bowles.*

DALRYMPLE (Gen. Sir Hew, Bart.) Memoir of his Proceedings as connected with the Affairs of Spain and the commencement of the Peninsular War. 1 Vol. 8vo. London, 1830. *Sir A. Dalrymple, Bart. Lt.-Gen.*

ELPHINSTONE (H. C.) Capt. R. E.

Journal of the Operations conducted by the Royal Engineers, from the Invasion of the Crimea to the close of the Winter Campaign, 1854-55. Part I. London, 8vo., 1859.

Part II., from February 1855 to the Fall of Sevastopol, September 1855. By Maj.-Gen. Sir H. D. Jones, R. E., K.C.B.

An account of the Artillery Operations conducted by the Royal Artillery and Naval Brigade before Sevastopol in 1854 and 1855. By Capt E. M. Reilly, R.A., C.B.

Secretary of State for War.

ELLIS (W. B. E.) Lieut. R.A. Military Notes written at Secunderabad, India. Pamph. 8vo. Secunderabad, 1859. *The Author.*

ESTE (M. L.) Esq. M.D. England in relation with other Countries' Revolutions and their Wars. Pamph. 8vo. 3 copies. *The Author.*

FABRIZI (Jean). L'Italie après la Guerre. Traduit de l' Italien et précédé d' une introduction par M. Martin Doisy. Pamph. Paris, 8vo., 1859. *Jno. Barrow, Esq., F.R.S.*

FAIRPLAY. A Plea for the British Soldier. Pamph. 8vo. London, 1859. *The Author.*

GARDINER (General Sir R.) G.C.B. Minute on the Changes and Re-organization of the Royal Artillery. Pamph. 8vo. London, 1859. 3 copies, bound. *The Author.*

GALTON (Fras.) Esq. F.R.G.S. The Art of Travel. 3rd edition, small 8vo. London, 1860. *The Author.*

GAZETTE (New Zealand Government). Extract from No. 23, of the 14th July, 1859, containing a Lecture on the Geology of the Province of Auckland, New Zealand. *W. Gibsone, Esq., under Colonial Secretary, Auckland.*

GIRARDIN (Emile de). La Guerre. Pamph. 8vo. Paris, 1859. *Jno. Barrow, Esq., F.R.S., &c.*

GLOVER (Rev. F.R.A.) M.A. Harbours of Refuge not "Dangerous Decoys," "Ship Traps," nor "Wrecking Pools." 8vo. London, 1859. *The Author.*

GRIFFITHS (Major ret. f. p.) R.A. The Artillerist's Manual and British Soldier's Compendium. 12mo. London, 1859. 8th edition. *The Author.*

HAWES (Capt. B.) Rifle Ammunition, being Notes on the Manufacture connected therewith, as conducted in the Royal Arsenal, Woolwich. 8vo. London, 1859. *The Author.*

HEATH (Capt. L. G.) R.N. Description of a Method of Coiling Submarine Telegraph Cables. Pamph. 8vo. Portsea, 1859. 2 copies. *The Author.*

INDIAN ARMY, Thoughts on the Re-construction of. By a Retired Officer. Pamph. *The Author.*

JEFFRIES (Julius) Esq. F.R.S. The British Army in India; the Staff of India, &c. 1 Vol. 8vo. London, 1858. *The Author.*

JOURNAL Militaire, Nos. 4, 5, 6. Mémoires du Depôt Topographique Militaire, Nos. 1—20. *The Russian Government.*

KENNEDY (S.) Lt.-Gen. C.B. Notes on the Defences of Great Britain and Ireland. Pamph. 8vo. London, 1859. *The Author.*

LIGNALL (Thomas) Esq. F.R.S.L. Rifled Ordnance; a Practical Treatise on the application of the principle of the Rifle to Guns and Mortars of every calibre, &c. Pamph. 8vo. London, 1859. *The Author.*

MALTON (W. D.) M.A., late Lieut. Royal Edmonton Rifles. Company and Battalion-drill, illustrated. 8vo. London, 1859. 2nd edition. *The Author.*

The A. B. C. of Skirmishing; being the Light Infantry Movements of a Company. Pamph. 12mo. London, 1859. *The Author.*

MALTE BRUN. Géographie du Theâtre de la Guerre d' Italie, illustrée par Gustave Doré. Pamph. 4to. Paris. *Jno. Barrow, Esq., F.R.S., &c.*

MOORSOM (Vice-Admiral). Performances of Steam Vessels. Pamph. 8vo. London, 1859. *The Author.*

MOULVEE MOHUMMUD MUSSEEHOOD-DEEN KHAN BAHADOOR. Oude, its Princes and its Government vindicated. 1 Vol. 8vo. London, 1857.

Dacoitee in Excelsis, or the Spoliation of Oude by the E. I. Company. 1 Vol. 8vo. London. *Captain Craven.*

NATIONAL LIFE BOAT INSTITUTION, Journal of. Vol. IV. Nos. 33, 34. *The Institution.*

NOLLOTH (M. S.) Captain R.N. Reminiscences of St. Domingo in 1849. Pamph. 8vo. *The Author.*

OWEN (Major) and DAMES (Capt.), R.A. Elementary Lectures on Artillery; prepared for the Use of the Gentlemen Cadets of the Royal Military Academy. 1 Vol. 8vo. Woolwich, 1859. *The Authors.*

PATENTS FOR INVENTIONS:

Abridgments of the Specification relating to Marine Propulsion. Parts 1, 2, 3.

Specification relating to Motive Power and Propelling Vessels.

Ditto, ditto, Aërial Navigation.

The Propulsion of Vessels, Carriages, &c.

Ditto, ditto, Propelling Vessels.

James Reddie, Esq.

PERIGAL (Fredk.) Esq. Chart of Naval History. 1859. *The Author.*

PORTLOCK, (Major-Gen.), LL.D. Reform or no Reform for the Army, that is the Question. Pamph. 8vo. London, 1858. 2 copies. *The Author.*

RAMCHUNDRA, late Teacher of Science, Delhi College. A Treatise on Problems of Maxima and Minima solved by Algebra. 1 Vol. 8vo. London, 1859. *Secretary of State for India.*

ROYAL AGRICULTURAL SOCIETY OF ENGLAND. Journal of. Vol. XX. Part 1, No. 43. *The Society.*

ROYAL ARTILLERY INSTITUTION. Minutes of Proceedings of. Vol. I. 8vo. Woolwich.

Ditto, ditto, from page 1 to 120. Vol. II.

Occasional Papers. Vol. I. Nos. 12, 13, 14, 15, 16, 17. *The Institution.*

ROYAL ASIATIC SOCIETY OF GREAT BRITAIN AND IRELAND, Journal of. Vol. XVII. Part 1. 8vo. London, 1859. *The Society.*

ROYAL Astronomical Society. Memoirs of the Society. Vol. XXVII. 1857, 1858.

Astronomical, Magnetical, and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1857.

Monthly Notices of the Society from Nov. 1857 to July 1858.

G. B. Airey, Esq. M.A.

ROYAL ENGINEERS. Professional Papers of the Corps of. Vol. VIII. New Series. 8vo. Woolwich, 1859. *The Editor.*

ROYAL GEOGRAPHICAL SOCIETY. Proceedings of. Vol. III. Nos. 3, 4, 5, 6.

Journal of. Vol. XXVIII. 1858. *The Society.*

ROYAL INSTITUTION OF GREAT BRITAIN. Lectures on Education, delivered at the Institution, London. Small 8vo. 1855.

Notices of the Proceedings at the Meeting of the Members. Part 9. Nov. 1858 to July 1859.

List of Members and Report of the Visitors for the Year 1858. *The Institution.*

ROYAL SOCIETY. Proceedings of. Vol. X. Nos. 35, 36. *The Society.*

SPRATT, (T.) Capt. R.N., C.B., F.R.S. A Dissertation on the true Position of Pelusium and Farama. With Plans. Folio. London, 1859. *Lords Commissioners of the Admiralty.*

TIDSKRIFT for Sævæsen. 1 Vol. 1858. Copenhagen.

TIDSKRIFT for Krigsvæsen. 1 Vol. 1858. Copenhagen. *Danish Government.*

TURNER (Mr. George). Description and Observations on improved Military and other Tents, Marquees, &c. Pamph. London, 1858. 2 copies. French and English. *The Author.*

WILCOX (C. M.). Rifles and Rifle Practice. 8vo. New York, 1859. *Captain Burgess.*

ZOOLOGICAL SOCIETY OF LONDON. Proceedings of. Pages 369—560. With Index.

Ditto, ditto, Part 1. Jan. to March, 1859.

Ditto, ditto, Part 2. March to June, 1859.

Transactions of. Vol. IV. Part 6. 1859. *The Society.*

MAPS, PLANS, AND CHARTS.

Map of Northern Italy in 4 sheets. 2 copies.

Plan of the Battle of Magenta. 2 copies. (With description.)

Plan of the Neighbourhood of Verona, Mantua, Peschiera, and Legnano. 2 copies.

French Official Report of the Battle of Solferino.

Map of the Island of St. Helena. 2 copies.

Maps and plans of the Siege of Sevastopol. 1 case.

Map of the Country Around Pekin. Copied from the Chinese Map of Asia, 1760. 2 copies. *Secretary of State for War.*

73 New Admiralty Charts.

3 Corrected do.

20 Books and Pamphlets.

Plan of the Mouth of the Tien-Sing-Ho. *The Lords Commissioners of the Admiralty.*

A Series of Maps. 23 vols. *Lord Lindsay.*

Plan of the ever memorable Engagement of Abukir at the Mouth of the Nile on 1st of August, 1796. *Henry Leader, Esq.*

Manuscript Plan of the March of the Imperial Austrian Army commanded by His Excellency Count de Sackendorff, passing the Rhine at Mayence. Campaign in 1735.

Map of the Upper Rhine from Skeyer to Mayence, 1735. *Lieut.-Col. Paschal.*

Maillard's Chart for determining the difference of Time in Longitude in all parts of the World by a simple bearing of the Sun or other heavenly body. *N. D. Maillard, Esq.*

2 Charts of the Arctic Discoveries. *James Wyld, Esq.*

Topographic and Military Map of the Netherlands. Part No. 58. *The Government of the Netherlands.*

De Barre's Original Survey of the Coast of Canada. 2 vols. Folio. *Vice-Admiral Gambier.*

Plan of Morocco.

Map to Illustrate the War in China. *James Wyld, Esq.*

AUTOGRAPHS.

Autograph Letter of Sir Colin Campbell, K.C.B., &c. *J. Barrow, Esq. F.R.G.S.&c.*

DRAWINGS AND ENGRAVINGS.

Framed and Varnished Plate of Rhodes's New Systems of Tent Architecture. *Major G. Rhodes, unattached.*

A Set of Chinese Paintings, shewing the process of casting cannon. *H. W. Hoskins, Esq.*

Photograph of the Yacht "Fox." *Lieut. Cheyne, R.N.*

Lithograph of the Monument to the Officers of the 68th Regiment who died during the Russian war. Framed and glazed. *Lieut.-Col. Lewis, late 68th, in the name of the Regiment.*

MUSEUM.

MILITARY.

Specimen of his Elongated Shot on the expanding principle, taken from the expanding lotus pith base of Malay tube arrow or dart, and submitted to the Select Committee at Woolwich in the summer of 1823.

Elongated Rifle Shot with Wooden Wings for Rifled Ordnance.

2 Elongated Rifle Shells (new pattern). *Captain Norton.*

The Arms, Accoutrements, Clothing, and Equipment of a Sardinian Grenadier, Bersaglieri, Cavalry, and Horse Artillery Soldier. *The Sardinian Government.*

The Arms, Accoutrements, Clothing, and Field Equipments of a Soldier of the Line and Light Infantry of the Belgian Army. *The Belgian Government.*

2 Cartridges invented by Dr. le Messurier, H. M. Madras Army. *The Inventor.*

An American Volcanic Repeating Pistol, with Cartridges. *E. Haslewood. Esq.*

Model of Rhodes's Hospital Tent.
Ditto Ditto Field Tent. *Major G. Rhodes, unattached.*

1 Bow and 4 Arrows.
2 Long Spears.
5 Short Spears.
3 Dirks in sheaths.
1 Quiver.
1 Stick and Ball at the end.
1 Shield.
2 Battle Axes.
From Central Africa, brought home by Capts. Burton and Speke. *The Royal Geographical Society.*

Sword picked up on the field after the action at Jellalabad.

Affghan Sword brought from Affghanistan, by the late Major Fenwick, 13th Light Infantry.

Shield found after the capture of Ghuznee, by the late Major Fenwick, 13th Light Infantry. *Mrs. Fenwick.*

Matchlock and Sword (two small bells attached to the hilt) from Borneo. *Captain E. G. Fishbourne, R.N., C.B.*

NAVAL.

Model of a Gun-boat.
H. G. the Duke of Northumberland.

Model of a Man of War, put together in a glass bottle by a French prisoner in Norman Cross Prison in 1810.
Com. R. M. Cole, R.N.

MISCELLANEOUS.

Specimen of Iron from a 68-pr. gun burst in second round of proof, showing the grain.

Specimen of Metal from Cascable of a 6-pounder gun cast at the Royal Gun Factories, Woolwich.
Lieut.-Col. E. Wilmot, R.A.

Wooden Sight for correcting the dispart of a gun, found in one of the batteries captured in the Canton Expedition, 1847. *Sir John F. Davies, Bart. K.C.B.*

Arab Stirrups, Bit, Pouch, Belts, and Water-bottle, embroidered.
Captain A. C. Tupper.

1 Umbrella and Spear, 1 Boat-flag, 2 pairs of Stirrup-irons, 1 Double Bridle-bit, 1 Flat piece of Iron. From Central Africa. Brought home by Captains Burton and Speke.
Royal Geographical Society.

Three Leathern Bags, which contained the Dispatches of the Battles of Alma and Inkerman and Capture of Sevastopol.
Mr. E. Kiddle, War Department.

Two specimens of Antimonial Copper from the Wheal Anna Maria Mine at Port Navis, Cornwall.
Geo. A. Copeland, Esq.

A curious Blade Chain-Shot used by the Rebels in India at the Capture of the City of Kotah in Rajpootana, on the 30th March, 1858.
Colonel J. C. Raines, 95th Regt. C.B.

Package of Cartridges made at Lucknow by Col. North, 60th Rifles.
Colonel North.

Live Shell, supposed to have been thrown from one of the new French rifle cannon at the Battle of Solferino, brought from the field by J. B. Herbert, Esq.
J. B. Herbert, Esq.

1 Bullet, 1 Cartridge, from the battle-field of Solferino.
John Barrow. Esq. F.R.S. &c.

A Box to hold the signal-book of the Chesapeake, made from the timbers of H. M. Ship Shannon, now being broken up at Chatham.
Capt. G. Goldsmith, R.N., C.B.

A Hoof of "Jock," the last surviving horse of the 2d Life Guards, present at the Battle of Waterloo in 1815. Shot and buried in Hyde Park, 29th June, 1836. *Lieut.-Col. G. F. Paschal.*

2 Small Gold Boats, attached to the ribbon of the Medal granted to the late Sir William Hillary, Bart. See Journal, Vol. III. page 226.

No. 1. Voted January 16, 1828, in acknowledgment of his gallant services in putting off in a shore-boat and assisting to rescue the crew of eleven men and five Manx sailors from the Swedish ship Fortroindert, which was wrecked off Douglas, Isle of Man, during a heavy gale of wind, on the 10th December, 1827.

No. 2. Voted January 27, 1836, in testimony of his intrepid services in putting off in the Douglas lifeboat and rescuing seven men from the sloop Eclipse, which was wrecked in Douglas Bay, during a very heavy gale of wind, on the 14th January, 1830.
Walter Hawkins, Esq. F.S.A.

Form of Bequest.

I give and bequeath unto THE ROYAL UNITED SERVICE INSTITUTION, *situated in Whitehall Yard, London, the sum of*

to be applied in and towards carrying on the designs of the said Institution, such Legacy to be paid out of such part of my Personal Estate not specifically bequeathed as the law permits to be appropriated by Will to Charitable Purposes.

ROYAL
UNITED SERVICE INSTITUTION.

Charter of Incorporation.

Victoria by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith, **To all to whom** these presents shall come, **Greeting**:

Whereas our right trusty and right entirely beloved Cousin and Councillor, Algernon Percy, Duke of Northumberland, Knight of the Most Noble Order of the Garter, Vice-Admiral, and others of our loving subjects, have, by their Petition, humbly represented unto us that they are Members of a Society, established in the year one thousand eight hundred and thirty-one, under the title of "The Naval and Military Library and Museum," but since called "The United Service Institution," of which His late Majesty King William the Fourth was the founder;

That such Society has sedulously encouraged

and extended Naval and Military Science and Literature, and that it would further tend to the promotion and advancement of Naval and Military Science and Literature if we granted to the said Algernon Percy, Duke of Northumberland, and to those who are now Members of the said Society, our Royal Charter of Incorporation;

Now know ye, That We, being desirous of encouraging a design so laudable and salutary, of our especial grace, certain knowledge, and mere motion, **Have** willed, granted, and declared, and **Do** by these presents, for Us, our heirs and successors, will, grant, and declare, that the said Algernon Percy, Duke of Northumberland, and such other of our loving subjects as now are Members of the said Society, or shall from time to time become Members thereof, according to such regulations or bye-laws as shall be hereafter framed or enacted, and their successors, shall, during such time as they shall respectively continue to be such Members, be by virtue of these presents one body politic and corporate, by the name of "THE ROYAL UNITED SERVICE INSTITUTION," and for the purposes aforesaid and by the name aforesaid shall have perpetual succession and a common seal, with full power and authority to alter, vary, break, and renew the same at their discretion, and by the same name to sue

and be sued, implead and be impleaded, answer and be answered unto, in every court of Us, our heirs and successors, and be for ever able and capable in the law to purchase, receive, possess, hold, and enjoy, to them and their successors, any goods and chattels whatsoever, and as well those as now belong to the said Institution as those which may be hereafter acquired; and also to be able and capable in the law (notwithstanding the Statute of Mortmain) to take, purchase, hold, and enjoy to them and their successors a Hall or House, and any such messuages, lands, tenements, or hereditaments whatsoever as may be necessary for carrying out the purposes of the said Society, the yearly value of which, including the site of the said hall or house, shall not exceed in the whole the sum of two thousand pounds, computing the same respectively at the rack-rent which might have been gotten for the same respectively at the time of the purchase or acquisition thereof; and to act in all the concerns of the said body politic and corporate as effectually, to all intents and purposes, as any other of our liege subjects in our said kingdom not being under any disability might do in their respective concerns.

And We do hereby Grant our especial licence and authority unto all and every person and persons,

bodies politic and corporate, otherwise competent, to grant, sell, alien, and convey in mortmain unto and to the said body politic and corporate and their successors, any messuages, lands, tenements, and hereditaments, not exceeding such annual value as aforesaid.

And Our will AND PLEASURE IS, and we do further will and declare, that there shall be Patrons and Vice-Patrons, and a President and Vice-Presidents, of the said Institution, and that the said Algernon Percy, Duke of Northumberland, shall be the first President under this our Royal Charter of Incorporation, and that not more than Twenty-four nor less than Twelve Members, to be chosen by a General Meeting of the said Society, shall be the Council of the said body politic and corporate, of which the aforesaid President and Vice-Presidents shall be ex-officio Members; and, until such Members of the Council shall be elected, the present Members of the Council of the said Institution shall be the Council of the said body politic and corporate.

And We DO FURTHER WILL AND DECLARE, That there shall be a General Meeting of the Members of the said Society once in each year or oftener, and that if necessary the same shall be adjourned from time to time, and that the said General Meetings and the Council shall have the entire direction and manage-

ment of the concerns of the said body politic and corporate, in the manner and subject to the regulations hereinafter mentioned.

And We do further will and declare, That the said General Meetings shall from time to time make and establish such bye-laws, and vary, and alter, and revoke the same, as they shall deem to be useful and necessary, for the election of President, Vice-Presidents, and Council, and for the regulation of the said body politic and corporate, for the admission and expulsion of Members and of honorary and foreign Members, so that such bye-laws be not repugnant to these presents, or to the laws and statutes of this our realm; and shall and may also enter into any resolution and make any regulation respecting the affairs of the said body politic and corporate that may be necessary and proper, and shall not be repugnant to these presents, or to the said laws and statutes.

And We do further will and declare, That the General Meetings and adjourned General Meetings shall take place at such time as may be fixed by the said Council, and that the present rules, regulations, or bye-laws of the said Society, so far as they are not inconsistent with these presents, shall continue in force until the same shall be altered by a General Meeting.

And We DO FURTHER WILL AND DECLARE, That, notwithstanding anything herein contained, the Council shall have the sole management of the income and funds of the said body politic and corporate, the appointment of Secretary, Curator, and such officers, attendants, and servants as the Council shall think necessary or useful; and also the entire management and superintendence of all the other affairs of the said Society; and shall and may, but not inconsistently with or contrary to the provisions of this our Charter, or any existing bye-law or laws, or the laws and statutes of this our realm, do all such acts and deeds as shall appear to them necessary for carrying into effect the objects and views of the said body politic and corporate.

Provided always, and we do further will and declare, That the Council shall from time to time, and at least once in each year, render to a General Meeting a full account of their proceedings, and that every Member of the Society may at all reasonable times, to be fixed by the Council, see and examine the accounts of the receipts and payments of the said body politic and corporate.

And We DO FURTHER WILL AND DECLARE, That no sale, mortgage, incumbrance, or other disposition of any messuages, lands, tenements, or hereditaments belonging to the said body politic and

corporate shall be made, except with the approbation and concurrence of a General Meeting.

And We DO FURTHER WILL AND DECLARE, That it shall be lawful for the Council of the said Institution, with the approbation and concurrence of a General Meeting, from time to time to appoint any persons to be Trustees of any part of the property of the said body politic and corporate, and to make, or direct to be made, any conveyance or transfer to such Trustees.

In witness whereof we have caused these our Letters to be made Patent.

Witness Ourself, at Our Palace at Westminster, this twenty-second day of February, in the twenty-third year of our reign.

By Her Majesty's command,

Edmunds.

Seal.

ROYAL UNITED SERVICE INSTITUTION.

DESIGN.

The promotion of Naval and Military Art, Science, and Literature, is the object of the ROYAL UNITED SERVICE INSTITUTION.

The principal means by which this object is sought to be attained are, —the formation of a Library containing Historical, Scientific, and Professional Works, Maps, Charts, and Plans ; the delivery of Lectures ; the exhibition of Inventions ; and the publication of a Journal ; a collection of Arms of all Nations ; and a Museum, which shall serve as a Central Repository for objects of Professional Information, and for Trophies and Relics, &c., connected with distinguished Officers, and Naval and Military operations.

BYE LAWS.

SECTION I.

1. There shall be Patrons and Vice-Patrons.
2. PATRONS: The Sovereign and the Royal Consort.
3. VICE-PATRONS: limited to Members of the Royal Family; Officers eminently distinguished in the Service of the Country; and Members selected by the Council as having been benefactors to the Institution.
4. The following public Officers shall be Vice-Patrons during their continuance in office:—

1. The First Lord of the Treasury.
2. The Secretary of State for the Home Department.
3. The Secretary of State for Foreign Affairs.
4. The Secretary of State for the Colonies.
5. The Secretary of State for War.
6. The Secretary of State for India.
7. The First Lord of the Admiralty.
8. The Commander-in-Chief of Her Majesty's Forces.
9. The Lord-Lieutenant of Ireland.

SECTION II.—COMPOSITION.

1. Princes of the Blood-Royal; Lords Lieutenant of Counties; Governors of Colonies and Dependencies; Officers of the Army, Navy, Marines, Her Majesty's East Indian Military and Naval Forces, Militia, Yeomanry, and Volunteer Corps, shall be entitled to become Members *without Ballot*, on payment of the Entrance Fee and Annual Subscription.

2. Retired Officers, not previously Members; Deputy Lieutenants of Counties; Civil Functionaries who are or have been attached to the Naval and Military Departments; and Navy and Army Agents; shall be *eligible* to become Members by *Ballot.*

3. Gentlemen above the age of *fifteen*, whose names are on the list of the Commander-in-Chief for Commissions in the Army, or who are probationary for offices connected with the Naval and Military Professions, shall be *admissible*, by *Ballot*, to become PROVISIONAL MEMBERS from year to year, on payment of the Annual Subscription; after they obtain their appointments they shall become ordinary Members on payment of the Entrance Fee.

4. The Candidates referred to in Articles 2 and 3 must be recommended by two Members of the Institution on their personal knowledge; the Lists signed by the Secretary shall be put up in the Library or Reading Room, fourteen days before they are submitted for election to the Council of Management specially assembled.

SECTION III.—GOVERNMENT.

1. The Government shall consist of a President and twelve Vice-Presidents; and a Council of Management composed of twenty-four Members.

2. THE PRESIDENT OF THE INSTITUTION shall be elected by a General Meeting of the Members, and shall be a Member of the Council, *ex officio.*

3. THE VICE-PRESIDENTS shall be elected by the Council, of which they shall be *ex-officio* Members.

4. THE COUNCIL shall be elected by the General Meeting : Eight Members shall annually go out by rotation; three of the Members going out shall be eligible to be re-elected. The Council shall submit to the Annual General Meeting a list of not less than ten names from which the vacancies may be filled. Vacancies that occur during the year shall be filled up at the discretion of the Council ; the Members so elected going out by rotation as the Members would have done whose position they have been elected to fill.

5. After the Annual Meeting, the Council shall select a Chairman and Vice-Chairman for the ensuing year, one of whom, or a Vice-President, shall preside at its Meetings, except when the President of the Institution attends.

6. Five Members of the Council shall constitute a Quorum.

7. Two Vice-Presidents shall undertake the office of Visitors, who shall make a quarterly inspection of the Institution and its affairs, and report thereon to the Council.

8. The Council, shall have the custody of the Common Seal of the Corporation, and shall have full power and authority to affix the same to all deeds, documents, papers, and writings in the name and on behalf of the Corporation.

9. The Council shall appoint a Secretary and Curator, and such other officers, attendants, and servants, as they shall think necessary for the purposes of the Institution, with full power to suspend or dismiss the same,

and no such officer, attendant, or servant shall, either directly or indirectly, accept, receive, or take, from any person or persons whatsoever, any gratuity, fee, or reward whatsoever, other than and except the salary, wages, or emolument allowed by the Council.

SECTION IV.—Subscription.

1. *An Entrance* Fee of *One Pound* shall be paid by all Members on joining the Institution.

2. *Annual Subscriptions* shall be due on the 1st of January in each year: Subscribers of not less than *One Pound* a-year, shall, after the 1st of January, 1860, be entitled to receive the Journal from the date of their becoming Members.

3. Annual Subscribers of *Ten Shillings*, shall, after the 1st of January, 1860, receive as heretofore the Annual Report, but not the Journal.

4. After the 1st of January, 1860, all Subscribers of One Pound a-year shall, while serving on Foreign Stations, have their Subscription reduced to *Ten Shillings* a-year, commencing on the 1st of January succeeding their embarcation, if they express their wish to that effect in writing to the Secretary.

5. *Life Subscriptions.* After the 1st of January, 1860, the payment of a sum of *Nine Pounds*, in addition to the Entrance Fee, shall constitute a Member for Life, who shall be entitled to receive the Journal from the time of his becoming a Member.

6. *Life Subscribers* of *Six Pounds*, in addition to the Entrance Fee, shall receive as heretofore the Annual Report, but not the Journal.

7. Annual Subscribers of Ten Shillings and Life Subscribers of Six Pounds, while serving abroad, shall be entitled during such service to receive the current numbers of the Journal, on notifying their wish to that effect to the Secretary in writing.

8. Members who join the Institution on or after the 1st October in any year shall not be charged the ensuing Annual Subscription on the 1st of January.

9. Members failing to pay their Annual Subscriptions shall have their names removed from the List of Members, at the discretion of the Council.

10. Members whose names have been struck off for non-payment of their Subscriptions after repeated applications, shall be re-admissible only on payment of arrears from the date of last payment.

SECTION V.—Funds and Expenditure.

1. The management of the property, receipts, and payments of the Institution shall be confided to the Council, who shall authorise every payment by an order, signed by the Chairman at the Meeting, and another Member of Council present, and countersigned by the Secretary.

2. The Royal United Service Institution neither shall nor may make any dividend, gift, division, or bonus in money, unto or between any of its

Members out of its present property, or out of any property which it may hereafter acquire, and the whole of its property, both present and future, shall be exclusively applied for carrying into effect its design as an establishment for the promotion of Naval and Military Art, Science, and Literature.

3. The funds of the Institution and all Life Subscriptions and Legacies, shall be invested in eligible securities, in the names of Trustees, selected by the Council, with the approbation and concurrence of a General Meeting.

4. All cash received on behalf of the Institution by the Secretary shall be paid by him to the Bankers of the Institution.

SECTION VI.—Auditors.

1. There shall be three Auditors, not Members of the Council, who shall be elected by the General Annual Meeting to audit the accounts, one of whom shall annually go out by rotation, but shall be eligible for re-election.

2. Two Auditors shall be a quorum.

3. Vacancies that occur other than those caused by the Auditor going out by rotation shall be filled up at the discretion of the Council; the Auditor so elected, going out in rotation as the Auditor would have done whose position he has been elected to fill.

4. The Auditors shall meet and examine and sign the yearly accounts, adding thereto any remarks, and making such inquiries as they may deem proper.

5. After the Audit, and at least fourteen days before the General Annual Meeting, the Annual Report, with an abstract of the accounts, and estimate of the probable expense for the ensuing year, shall be printed, and circulated among the Members.

SECTION VII.—General Meetings.

1. A General Meeting shall be annually held on the first Saturday in March; that day being considered the Anniversary of the Institution.

2. The Council may call a Special General Meeting on giving fourteen days' notice—which notice must be suspended in the Library or Reading Room, and advertised in two military papers, specifying the object or objects in contemplation, and explicitly stating that the discussion shall be strictly confined to those objects.

3. The Council shall call a Special General Meeting, on the written requisition of not less than Twenty-four Members, within one calendar month from the date of such requisition, subject to the notices and restrictions above-mentioned.

4. At the General Meetings, in case of an equality of votes, the Chairman shall have a second or casting vote.

5 No Member shall be entitled to speak or vote at any General Meet-

ing, or at any Special General Meeting, or at any adjournment thereof, unless he shall have paid his subscriptions up to the day of payment next preceding such Meeting.

6. That any General or Special General Meeting, finding the current day insufficient for its intended purpose, may adjourn to the succeeding or any future day or days, until the business be concluded.

7. That no business shall be transacted at any Annual General Meeting other than that submitted by the Council, or by the direction of the Council, unless notice thereof be suspended in the Library or Reading Room at least fourteen days prior to the day appointed for such Annual General Meeting, specifying the object or objects in contemplation, to which objects the discussion must be strictly confined.

SECTION VIII.—Making or Repealing Bye Laws.

Should it be proposed to make or repeal a Bye Law, the proposition to such effect, signed by the proposer and seconder, shall be suspended in the Library or Reading Room for fourteen days; after which the question shall be determined by a majority of at least two-thirds of the Members present at the next General Meeting.

SECTION IX.—Mode of Voting.

All questions to be decided by a show of hands, unless a Ballot be demanded.

SECTION X.—Honorary Members.

1. The Council shall have the power of admitting Honorary and Corresponding Members.

2. Foreigners of Distinction may be admitted as Honorary and Corresponding Members.

3. Eminent Individuals and Benefactors to the Institution, not otherwise eligible, may be admitted as Honorary Members.

4. The Diplomatic Body shall be invited to become Honorary Members; and shall be privileged to submit the names of foreign noblemen and gentlemen, resident in England, to the Council, in order that the same courtesy may be extended to them, for the space of Three Months: this privilege to be renewed to such strangers, if desired, on the written application of their respective Ambassadors, or at the recommendation of some Member to whom they may be personally known.

5. Foreign Naval and Military Officers may be admitted as Honorary and Corresponding Members.

6. Ladies, who contribute to the Institution, may be admitted as Honorary Members.

SECTION XI.—Contributions.

The name of each Contributor shall be recorded, with a specification of the gift.

SECTION XII.—Hours of Reception—Visitors.

1. The Museum of the Institution shall be open daily (Sundays excepted) from 11 to 5 in Summer, and from 11 to 4 in Winter.* Printed tickets for the admission of visitors are available every day except Friday, on which day, a personal introduction by a Member is necessary. The names of Visitors to be inscribed in a book kept for the purpose.

2. The Libraries and Reading Rooms shall be kept open (Sundays excepted) for the use of Members only, till eight in the evening, or to a later hour, at the discretion of the Council.

3. The Museum shall be closed to Visitors when necessary, at the discretion of the Council.

SECTION XIII.—Expulsion.

1. Any Member who shall be removed from the Public Service for causes affecting his character shall cease to belong to the Institution.

2. In case the Council should think it expedient to submit the conduct of any Member to the judgment of a General Meeting, the Council shall call a Special General Meeting; and in the event of its being voted at that Meeting, by two-thirds of the Members present (to be decided by ballot), that such Member should be removed from the Institution, then, in that case, the name of such Member shall accordingly be erased from the list of Members, and he shall cease to belong to the Institution.

3. In case the Member is a Life Subscriber, he shall forfeit all claim on the Institution upon his expulsion.

* Winter months—October to March inclusive.

